The Journal
of the
Mysore Agricultural
and
Experimental Union

IMP. INST. ENT.
— LIBRARY —
18 JUN 1934
SERIAL A.6
SEPARATE

Vol. XIII — 1932

PRINTED AT THE BANGALORE PRESS, MYSORE ROAD
BANGALORE CITY
1933

The Journal

of the

Mysore Agricultural

and

Experimental Union

CONTENTS.

VOL. XIII.

No. 1.

	Page
Mysore Coffee Experiment Station, Balehonnur ..	1
The Irwin Canal Farm—By Dr. B. Narasimha Iyengar, B.A., Ph.D.	3
River-bed Cultivation in the Shimoga District—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.	7
A New Contrivance for the Control of the Early Stages of the Jola Grasshopper—By T. V. Subramaniam.. ..	11
Anthrax—By K. Ranganatha Rao, G.B.V.C.	13
SELECTIONS—	
Honey as a Medicine	19
Agriculture and Economic Depression	19
Artificial Production of Rain	20
Toxicity of Root Excretions	21
Conservation of Grass in Transportable Farm-Grass Cakes	23
Management of Farmyard Manure	25
Vegetative Propagation	28
Indian Sugar Industry in 1930-31	31
By-Products of the Sugarcane Industry	36
The Rise of Bee-Keeping	50
Award of the Maynard-Ganga Ram Prize	56

No. 2.

The Insecticidal Properties of Indigenous Vegetable Fish Poisons—By T. V. Subramaniam	57
Groundnut: Soil, Rainfall, Cultivation, Varieties under Cultivation, Pests and Diseases—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.)	60
SELECTIONS—	
No Loss of Moisture by Capillarity in our Dry-Farming Areas	82
Grafting *versus* Seeds in Coffee	83
The A.I.V. Process of Conserving Green Fodder ..	84
Poultry Keeping	86
Practical Immunization of Plants by Genetic Methods ..	88
Green Manuring of Paddy	93
Science and Animal Production. Breeding: The Application of Genetics	100

No. 3.

Page

Downy Mildew : A Serious Disease of Grape Vines in Mysore—By S. V. Venkatarayan, B.A. 107

Cultivation of Virginia Tobacco in Whitefield—By T. S. Raghavachar, B.A. 110

Ground-nut : Its Production, Composition and Uses—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.) .. 115

Johne's Disease—By K. Ranganatha Rao, G.B.V.C. .. 132

Some Additional Money Crops for the Shimoga Malnad—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D. 135

SELECTIONS—

On the Growth of Cocoanut Roots 138

Coffee Grafting 138

Potato Growing in Victoria 140

World Industry in Cocoanut Palm Products 144

Sesamum 149

No. 4.

In Memoriam : Dr. M. K. Venkata Rao, M.A., M.Sc., Ph.D.—By M. J. Narasimhan 163

The Fourteenth Annual Session of the Agricultural and Experimental Union—

Speech by Dr. Leslie C. Coleman, C.I.E., M.A., Ph.D. (*President*) 166

Annual Report by the Secretary 171

Opening Speech by S. P. Rajagopalachari, Esq., B.A., B.L., *Member of Council* 178

Ground-nut : Commerce—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.) 181

SELECTIONS—

Field Propagation of Cotton by means of Grafts .. 197

A Note on Tung Oil 198

Notes on Tobacco Cultivation 199

Some Methods of Grafting 201

ILLUSTRATIONS.

No. 1.

Page

Opening of the Laboratory of the Mysore Coffee Experiment Station, Balehonnur .. .. .. *Frontispiece*

Putting Manure in furrows
Irrigation furrows and planting cane
Ploughing with a mould-board plough
Opening furrows with a mould-board plough
Applying sulphate of ammonia to young cane crop
Ridging with a mould-board plough when cane is 3 months old
Method of zig-zag irrigation
Cane Crop, 12 months old } 6—7

The Cultivation of Melons and Vegetables in the Tunga River-bed .. .. (Facing) 8

A New Contrivance for the Control of the early stages of the Jola Grasshopper, *Colemania sphenarioides*, Bol. (Facing) 12

Sketch of the Contrivance .. .. ..(Facing) 13

No. 2.

Relative Toxicity of Fish-poisons (Graph) ..(Facing) 58

Do. ..(Facing) 59

No. 3.

View of the underside of a grape-vine leaf attacked by downy mildew (Fig. 1) .. ..(Facing) 108

Downy mildew on the shoots and tendrils, showing dwarfing and deformation (Fig. 2) .. ..(Facing) 108

No. 4.

Late Dr. M. K. Venkata Rao, M.A., M.Sc., Ph.D. ..(Facing) 163

Opening of the Laboratory of the Mysore Coffee Experiment Station, Balehonnur

His Highness the Maharaja of Mysore in the centre,
Dr. L. C. Coleman, Director of Agriculture, and Dewan Bahadur Mr. M. N. Krishna Rao,
Offg. Dewan of Mysore, in the extreme right

The Journal
of the
Mysore Agricultural
and
Experimental Union

Vol. XIII. 1932. No. 1

Mysore Coffee Experiment Station, Balehonnur.

The Laboratory of the Mysore Coffee Experiment Station was formally opened by His Highness the Maharaja of Mysore on the afternoon of the 27th November 1931. This event must be looked upon as a very important landmark in the development of the Station. His Highness' gracious and inspiring address at the opening of the Station has already been published in the Journal. It remains to give a brief account of the two days' proceedings of which this was a fitting climax.

About one thousand invitations were sent out to coffee planters in all parts of South India and notwithstanding the fact that the coffee harvest season had commenced there was a very gratifying response. It is estimated that between 400 and 500 coffee planters were present. In addition to the large number of planters from the various Mysore coffee districts we had visitors from Coorg, the Annamalais and the Nilgiris.

The first day was given over to conducting visitors over the Station. Officers of the Chemical, Entomological and Mycological sections of the Agricultural Department had arranged exhibits illustrating the more important features of work under their charge. Mr. Mayne exhibited various features of his investigations of leaf

disease, Die Back, and Root Rot. Thus Mr. N. Sampatiengar, Officiating Chemist, demonstrated methods of estimating acidity of the soil and exhibited samples of the various fertilizers. Mr. T. V. Subramaniam, Officiating Entomologist, showed the life history of borer, and green bugs and the methods of control. There was also an interesting agricultural exhibit which attracted a great deal of attention. Mr. M. J. Narasimhan, Officiating Mycologist, showed features of his work on Black Rot and also demonstrated the effects of preparing Bordeaux mixture by different methods.

A handbook which describes the work of the Station and the various experiments that are being carried on in the field had been prepared in both English and Kannada and was distributed to visitors. This handbook contains a map showing the location of all the experimental plots. In addition arrangements had been made by the staff of the Station to conduct parties of visitors over the Station and to explain the various field experiments. Perhaps the chief interest displayed was in the experiments upon grafting and spraying and the grafting and spraying demonstrations. The methods of grafting recommended were demonstrated by the grafter. Different types of spraying machines were shown working while the comparison between sprayed and unsprayed plots as regards both amount of crop and number of leaves in the trees was very striking indeed.

Arrangements had been made at Balehonnur and on neighbouring estates to entertain visitors over night and a large number were accommodated in this way.

The afternoon of the 26th and the morning of the 27th were devoted to inspection of the Station by visitors while the 27th afternoon was set apart for the opening function. The opening which was preceded by the presentation of an address to His Highness the Maharaja and His Highness' reply was a simple and impressive ceremony.

His Highness who honoured the Station by spending three nights there devoted the morning of the 28th to a very thorough inspection of the Station including the Laboratory. He was accompanied by Mr. M. N. Krishna Rao, Officiating Dewan, Mr. T. Thamboo Chetty, Huzur Secretary, Mr. Sadeg Z. Shah, Assistant Secretary and Captain

Nabi Khan, A.D.C. The staff of the Station and the Department as a whole have felt themselves signally honoured by the interest that His Highness has displayed in this work for the development of the Mysore Malnad.

The success of the function was mainly due to the energy and devotion displayed by the late Dr. M. K. Venkata Rao and Mr. K. H. Srinivasan, the Farm Manager, who were responsible for the excellent arrangements made for the Field Day.

LESLIE C. COLEMAN.

The Irwin Canal Farm.

BY

B. Narasimha Iyengar, B.A., Ph.D.
Agricultural Chemist.

A brief note dealing with soil conditions in the Irwin Canal Tract has already been published in this Journal (*vide* Vol. XI, No. 4). As a result of the new policy of irrigation decided upon for introduction in the tract—a system based on a regular rotation of crops in which paddy is allowed to be grown on any piece of land only once in three years—the establishment of a large Agricultural Station to study the problems peculiar to the tract, devise proper kinds of rotation, find out suitable varieties of crops, and supply the best possible seed to the raiyats, became a necessity and was sanctioned by Government in the latter part of June 1931.

The site selected for the Farm is six miles from Mandya railway station on the Bangalore-Mysore line, and is situated between the two main branches of the Irwin Canal, and draws its water-supply from the first sluice of the Cauvery branch. The site itself is a part of a subsidiary ridge nearly two miles in length from west to east and about three-fourths of a mile in width from south to north. The top of the ridge itself is almost flat and slopes gently from west to east. The side-slopes from the centre—towards north as well as south—are rather sharp in some places.

The site was selected after detailed soil survey work in the whole tract of over 1,20,000 acres, and so far as soil conditions are concerned it is quite representative of the whole tract.

The area of the farm is nearly 600 acres, about 350 acres of which were poor pasture land belonging to Government and 250 acres of private land recently acquired for the purpose. About one-half of the area consists of good friable red loam of an average depth of 2 to 3 feet, and the other half is either stony or gravelly. Here and there in the area, there do exist patches of sandy soil, and quite close to the water courses which form the boundaries on the northern and southern sides are to be found small strips of clay soil with lime-stone nodules embedded in it.

As the Irwin Canal Tract with its assured water-supply is capable of being developed as an area of intensive cultivation of sugarcane with a view to start sugar factories in it, the operations on the farm itself commenced with cane cultivation in July 1931.

With the hope of getting the farm sanctioned by Government in due course, a bit of 10 acres of Government waste land quite near the top of the ridge was got ploughed for the first time in November 1930. Due to want of adequate and well distributed rainfall, the land in question had a very scanty growth of grass which used to be scraped away by the neighbouring villagers as soon as it had made a couple of inches of growth after a shower of rain. As the chief requisite for good and successful cultivation in the area was water, further operations could not be started till the irrigation authorities supplied water in June 1931.

Agricultural operations were commenced in right earnest from July 1931 onwards. The already once ploughed land was cross-ploughed, harrowed, cultivated and laid out into plots of about 5/12th acre in size. As the variety of cane grown in tank-irrigated lands in the neighbourhood is a thin variety of cane called "cheni" seed material of an improved variety of cane—H.M. 320 – was got from the Hebbal Farm near Bangalore. Planting was commenced on 22nd July and finished on 10th August 1931. H.M. 320 cane was planted on an area of 10 acres only, and another 2 acres were planted with 8 other varieties of cane for comparative trials.

It may not be out of place to mention here a few details about the methods of cultivation and manuring followed.

After the field was prepared as mentioned previously, furrows were opened at a distance of 3 feet apart from each other. A mixture

of 1 cwt. of sulphate of ammonia and 1 cwt. of concentrated superphosphate per acre was applied in the furrows, irrigated and setts of cane planted immediately. The seed rate was 8,000 single setts per acre and each sett had 3 eye buds generally. About 6 to 8 weeks after planting, a second dose of sulphate of ammonia was applied in the furrows at the rate of 2 cwts. per acre and immediately irrigated. About 6 weeks later on, or 3 months after planting, groundnut oil-cake at 10 cwt. per acre and compost manure at 3 tons per acre were applied in the furrows and the crop was earthed up. About 30 rows of 25 feet each in length were then connected with each other, so that irrigation water could be run in a zig-zag manner round 30 rows at a time. The compost manure used was made by the Mysore Municipality out of street sweepings and night soil and contained 1 per cent nitrogen on an average.

To begin with, the land itself had a very sparse growth of grass. As very few weeds sprang up even later on, it may safely be said that the compost manure used was either absolutely free from weed seeds or their vitality at least had been destroyed during the process of making it.

After the crop was earthed up at the age of 3 months, the only attention paid to it was with regard to irrigation and it was given once in 4 or 5 days as was found necessary.

As the object was to use the crop entirely for seed purposes, it began to be harvested from April 1932 onwards, and the material obtained has now been planted on 207 acres on the farm itself. Besides, about 50,000 setts have been sold to private parties for seed purposes.

It may not be uninteresting to know the yield of crop grown as above on land coming under crop for the first time. The average yield for the whole area of 10 acres on which H.M. 320 cane was grown, worked out to 45 tons per acre. There were 24 plots in all and the yield from individual plots varied between 31 and 54 tons per acre according to the age at which the crop was cut. The number of setts obtained per acre varied, according to age of the crop, from 1,20,000 to 1,94,000. The total cost of cultivation up to harvest including cost of seed as well as manure has worked out to 210 rupees per acre.

The accompanying 8 photographs give some idea of all the operations connected with cane cultivation on the farm.

It is proposed to use up the material from the 200 and odd acres planted now for seed purposes on an area of 2,500 to 3,000 acres in the early part of 1933 so as to be able to have a sugar factory working early in 1934.

At present, the Irwin Canal Tract is an area of dry farming. The chief food crops that are being grown are mostly millets such as jola, ragi, navane, same. Jola is the main "mungar" or early rain crop and is followed by horsegram in the same year. Ragi and other millets are "hingar" or late rain crops and are grown next year as a rotation. Avare and niger are also sown along with ragi partly for fodder purposes and partly for grain. Gingelly, castor and groundnuts are the main oilseed crops.

With the introduction of irrigation, about one-third of the present area under the above crops will go under paddy, another third will go under money crops like sugarcane, and only the remaining third will be left for the cultivation of dry crops. Owing to precarious rainfall, the cultivator is not now sure of getting his dry crops at all; but the introduction of irrigation assures every crop to him. He need not entirely depend on local rainfall for timely water-supply to his crops.

Of the whole area surveyed, from one-half to one-third of it seems suited for the development of cane cultivation. As according to the system of irrigation to be introduced, one-third of the area has to come under money crops like sugarcane, and as every bit of land may not be suited for it or every cultivator may not be in a position to grow cane, it is necessary to suggest short-season crops so that two or more of them can be grown in one year as an alternative to sugarcane. Such short-season crops are groundnut, chillies, tobacco, turmeric, onions, garlic, cotton, irrigated ragi, etc.

To be able to make definite recommendations in due course and also to supply proper seed material, it is proposed to try the following rotations on the farm from 1933 onwards :—

A. Paddy, mungar crops and green manure, sugarcane.

B. Paddy, mungar and hingar crops, short-season crops.

C. Plant cane, ratoon cane, mungar crops and green manure.

D. Plant cane, mungar crops and green manure, or hingar crops.

Putting manure in furrows

Irrigating furrows and planting cane

Ploughing with a mould-board plough

Opening furrows with a mould-board plough

Applying sulphate of ammonia to young cane crop

Ridging with a mould-board plough when cane is 3 months old

Method of zig-zag irrigation

Cane crop, 12 months old

To reduce the area under paddy as far as possible and incidentally save the cost of levelling land into terraces, a two-year rotation is also included in the programme.

"May the Farm prosper and fulfil all our hopes" is the remark of a distinguished personage who visited the farm recently.

River-bed Cultivation in the Shimoga District.

BY

A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.

Deputy Director of Agriculture.

Melons of different kinds are grown in great profusion in the sandy riverbed of the Rivers Tunga and the Tungabhadra in many of the towns and villages lying along these rivers from Shimoga to Honnali and down to Harihar, and these green patches of cultivation in the midst of the stretches of dry sand and flowing water afford an interesting spectacle. It will be hard in fact to believe that the heaps of luscious melons and the various vegetables grown to perfection that arrive in cart loads in the markets of the bigger towns come from these little bits of greenery in what would appear most unpromising ground. But when one really comes to consider it, these areas possess peculiar advantages in their proximity to flowing water and in the ease of cultivation in such a porous and yielding material like sand. A method of cultivation has been evolved that utilizes these facilities admirably both by the selection of the crops suited to this condition and the technique necessary.

The crops grown are firstly the two different kinds of melons, *viz.*, (*Citrullus vulgaris*) and the musk or Siddhoti melon (*Cucumis melo*) with their many varieties, secondly the vegetables snakegourd, ribbedgourd, bittergourd, cucumbers, bottlegourd and the long podded cowpea, both white and purple. Both fruits and vegetables attain very large size and are exceptionally succulent.

The method of cultivation adopted is somewhat as follows :—

About the middle of January when the water in the river has gone low and all chances of its rising are over, the cultivation begins. Close to the edge of the water whether actually flowing or held up in shallow pools in the depressions here and there trenches are dug

about 1½ feet deep and 2 feet broad and as long as can be convenient to manage or as the situation will allow. The bottom of the trenches really touches the level of the underground water in the sand. At intervals of 1½ feet along the bottom of this trench, a handful of cattle manure powdered and well sifted is put in ; which in the course of the day settles flat and sodden with the moisture welling up. On the following day seedlings of the melon, which have been raised separately and which are 10 to 15 days old are transplanted in this wet manured sand at the rate of three seedlings in each hole. Ten days after the transplanting the soil round the seedlings is slightly loosened and the plants are earthed up slightly all around. About five days or a week thereafter, *i.e.*, about 15 days after transplanting, the first manuring called the Sanna gobra (or small manuring) is given, to be followed in about another 15 days with a second and final manuring called Dodda gobra or large manuring. It must be noted that every day the water in the river keeps receding and the level of the underground water below the plants also likewise keeps going lower and lower and the roots descend down rapidly to the level of the water. The manure is therefore given not merely around the upper roots but right down about the zone of the growing ends. The way in which these are manured is very interesting. Thus for the sanna gobra or first manuring they remove the sand from around the base of the plants carefully in two little arcs on opposite sides of the little mound of earth until the level of the under ground water is reached, the sand being drawn away to the sides. These little pits are filled with the same kind of powdered and sifted-cattle manure first on the one side and then on the other from the bottom to the base of the plants and piled in a neat heap. The roots of the plants grow rapidly and soon descend and spread through the moist manure to the level of the underground water. About 15 days after the above manuring, the second manuring is given in almost the same manner. Arc-like pits are again dug around the base of the plants one pit opposite another but different from the side manured in the first manuring. The arcs are also much larger than those of the first manuring. The sand is again drawn away to the sides, water being sprinkled on it to keep it firm and prevent it from sliding down into the pit. The pit is dug right down to the level of the sub-soil water, manure is filled in and piled in a

The cultivation of melons and vegetables in the Tunga river-bed

An archway of snakegourds

Foreground : Mounds of sand with a heavy crop of melons
Background : Arches with gourds of different kinds trained on them

neat heap around the base of the plant as in the first time. The second manuring is however not done on one and the same day, one arc is filled in first and the second one on the opposite side is dug and filled in about 5 days to a week thereafter. The area to be manured is thus handled roughly in four quadrants, the first two at one time, and the next two at intervals of a few days as stated above. The accompanying diagrammatic rough sketch illustrates

this method of manuring. After the second manuring is over, there is no more digging or stirring of the soil. The sand on both sides of the trench is carefully drawn away frequently and smoothened so as to facilitate the spreading of the creepers ; where several trenches adjoin, the surface assumes the shape of long mounds about 18 feet from crest to crest and separated by wide V-shaped trenches. The manuring is the most important and expensive item in the cultivation ; about 100 plants will require 10 cart loads. In two months after the second manuring or about $3\frac{1}{2}$ months from sowing the seed, the fruits are ready to pick. The fruits remain on the plants till they are quite ripe when they come off without the least effort separating naturally at the base from the union with the peduncle. About 10 fruits per hole is considered a good crop and they sell at prices ranging from annas three to annas twelve a piece depending upon the size and variety. The water melon attains large sizes but average ones may weigh about 9 lbs. each.

Quite a variety of different kinds are to be seen in both kinds of melons, which differ in shape, size, colour of skin, appearance and taste of the edible portion. Thus in the water-melon or Karbooj (*Citrullus vulgaris*) three forms are recognized: one has a very dark green skin, the second has a light pale green skin and the third has a dark green skin with a white shark-teeth pattern on it. All these are patronized indiscriminately, no special preference being

shown to any, they seem to be all alike in taste. Quality, however, depends upon the sweetness and of the depth of the flesh coloured portion of the interior which in the best ones extends right up from centre to the skin. As it is only the flesh coloured portion which is sweet and fit to eat, the larger the proportion of this part, the better the fruit.

There is the next class of melons (Siddhoti or *Cucumis melo*) akin to the musk or cantalope melon, of which the best called "Banaspatri" is a smooth-skinned fruit, pale yellow in colour with a firm cucumber-like flesh and a decided greenish tinge in the part of the flesh close to the skin. It is an extremely sweet fruit with pronounced flavour and is certainly the most popular. The other types vary a great deal; they are all much smaller in size compared with water-melon, have pale yellow to orange yellow skin, some smooth, some ribbed like a pumpkin and some with rough skin made by the skin cracking and callusing in a net-work-like pattern. The flesh does not fill the fruit entirely as in the case of the water-melon but resembles somewhat that of the cucumber in appearance, *i.e.*, with a decided hollow filled with seeds. The flesh is firm usually and is not so watery as the melon and in colour is uniform either white with a dash of green, or deep orange. All of them have a decided characteristic flavour and a consistency and taste peculiar to each. They are not by any means as sweet as Banaspatri and are only slightly so or not at all.

In addition to the melons great quantities of vegetables are grown also in much the same manner. The holes for sowing these are, however, made much closer to the water's edge as unlike the melons, these are watered frequently. The holes are made in two parallel rows about 8 feet apart and about 6 feet from each other in the rows. The application of the manure in two doses is done exactly as for the melons. As the plants grow, a special frame of bamboo standards is erected and bent inwards forming an archway on which the creeper climbs and spreads. When the archways are fully covered with the greenery they make a beautiful arbour and when in full bearing present a striking sight. Snakegourds, ribbed-gourds, bittergourds, cucumber and cowpea are grown in this manner on the arches, while the bottlegourds are grown only on the ground like the melons, without being provided with arches. In fact these

grow to such large sizes that the archways are out of the question as supports. The vegetable crops begin to get ready for picking in about $2\frac{1}{2}$ months from planting, and the melons in about $3\frac{1}{2}$ months. Started in January this riverbed cultivation goes on up to June when the river begins to rise with the monsoon floods. Cultivation is, however, taken up again about the beginning of September, from which month onwards the water gradually subsides and recedes. An unexpected rise in the river during the crop season is really the most dreaded event in the cultivation of these crops. Rains, hail and thunderstorms if earlier than usual do a great deal of damage resulting in much rotting of the fruit. Aphis and thrip attack is very general, the infestation is sometimes so severe as to completely shrivel up the young growth; cucumber crops being generally the most subject to this pest.

A New Contrivance for the Control of the Early Stages of the Jola Grasshopper, *Colemania sphenarioides*, Bol.

BY

T. V. Subramanya Iyer,

Offg. Entomologist.

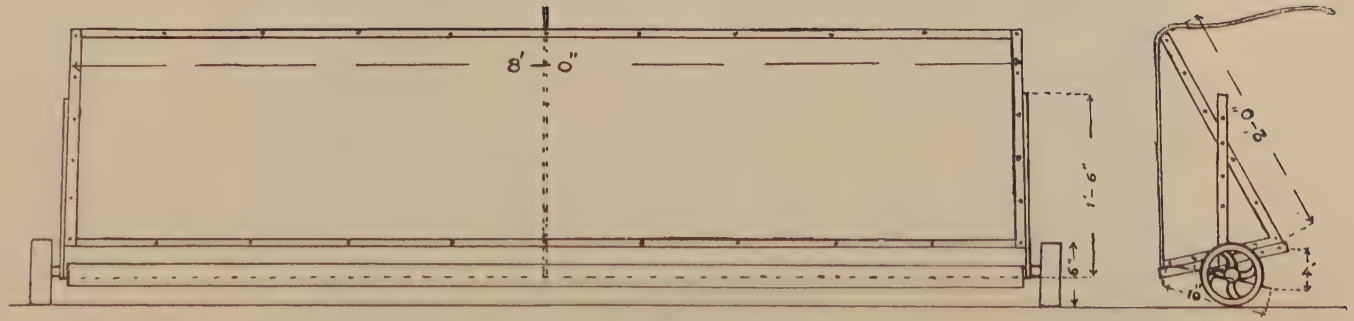
The Jola grasshopper, commonly known as the 'Deccan' grasshopper in other parts of India, after an absence of about 14 years, had reappeared in 1924 as a pest of jola (Sorghum), ragi (*Eleusine coracana*) and other cereals in the Northern and North-Western portions of the State. The insects were found to be increasing in numbers year after year and in 1928 they had assumed serious proportions doing great damage to crops. In the previous years the insects used to hatch out in numbers after the jola crop was about three weeks or a month old and the damage to the crops was not apparent then but in 1928, seeds were sown later than usual so that the sprouting of the seeds and the emergence of the young hoppers coincided and in consequence very large areas of young jola were destroyed and resowing had to be done two or three times, these too were destroyed by the hoppers and the fields had to be left unsown.

Bagging against the pest demonstrated by the Agricultural Department and resorted to by the ryots was not successful in the case of the pest on the early stages of the crop. Some other

means had to be adopted to combat the pest. For this purpose a light and handy contrivance, more or less on the principle of the "Hopper-dozers" of America was constructed by the aid of the village carpenter and tried in some fields fairly successfully. This is a frame-work made of two six feet length of wooden reapers joined in the middle and the ends by three small pieces $1\frac{1}{2}'$ long. To one side of this another similar frame-work was made to stand vertically. The horizontal and vertical portions were covered with date palm mats and a thick coating of tar was applied to the surface of the mat. The whole was mounted on four small wooden wheels giving a clearance of 2 to $2\frac{1}{2}$ inches between the frame-work and the ground. The cost of this contrivance came to about Rs. 4. As this was drawn over the infested crop by a man by means of a long rope attached to the two ends, a large number of young hoppers as they jumped off from the crop in all directions were caught on the horizontal and vertical tarred surfaces of the mat and they were too young to escape from the sticky surface. The tar coating had to be renewed often to make it effective. Large numbers of young hoppers were caught in infested fields and the work was found fairly satisfactory. As the contrivance was thought of and constructed when the damage to the crop was far advanced and the insects had moved on to the adjacent grown up crops it was not possible to give it an extensive trial that year.

In 1929 one or two contrivances similar to the above were made and during their trials several improvements and alterations were felt necessary and finally one was got made in a Government Workshop for trial. This was made of 8 feet length of angle iron and thin zinc sheets, mounted on two iron plough wheels with a standard. By means of the latter the height of the contrivance could be raised or lowered according to the size of the crop. Provision was made to hitch on bullocks to replace manual labour. The necessity for tar or other sticky material was avoided by the provision of a gap between the vertical and horizontal portions of the frame-work. This gap is enclosed by means of a cloth bag from behind so that when the contrivance is drawn over infested crop, the insects that jump off from the crop strike against the vertical zinc sheet and drop down through the gap into the bag and there is no way of escape for the insects. The cost of the pattern made for trial was

A new contrivance for the control of the early stages of the Jola Grasshopper, *Colemania sphenarioides,* Bol.



Front Elevation

Side Elevation

a little over Rs. 20 but the cost will be about 50 per cent less if made on a large scale.

Extensive trials were made with this and it was found to be as effective as the bagging done by manual labour in reducing the insects on the crops but with the great advantage of covering an area several times larger in a given time than that by manual labour. A pair of bullocks hitched on to this is able to cover an acre of field in about an hour whereas four men dragging a bag by turns are unable to cover even an acre per day. The ryots readily took to this and there was some demand for this in the grasshopper infested areas in 1929. The cost is against individual ryots owning any but this difficulty can be overcome by the village panchayats getting three or four made for each village and this number will be found more than enough for the whole of the infested areas in the village.

The writer is indebted to the late Dr. K. Kunhi Kannan, Entomologist, for valuable suggestions in the construction of this device.

Anthrax

(ನರಡಿ ರೋಗ, ಕುರಿ ಮೇಕೆಗಳ ಚಪ್ಪೆ ರೋಗ)

BY

K. Ranganatha Rao, G.B.V.C.,
Asst. Superintendent, C. V. D.

Anthrax, variously known as Charbon, splenic fever, or splenic apoplexy, is an acute infectious disease affecting every species of domestic animal, and occasionally man. It is caused by a germ which multiplies rapidly in the body especially in the blood and produces poisonous substances which cause death.

Anthrax sometimes believed to be not so common among the domesticated animals as Rinderpest, Hæmorrhagic Septicæmia or Blackquarter is much more prevalent than the official returns would indicate. Its importance is demonstrated by the high incidence of infection in the exported hides and wool.

1926–27	..	4,687
1927–28	..	4,202
1928–29	..	4,054
1929–30	..	4,432
1930–31	..	4,562

Moreover, as the disease is usually sporadic in its occurrence, and but rarely gives rise to considerable outbreaks, it is inevitable that deaths caused by it pass most often undiagnosed; the carcases are then frequently skinned, the infected hides constituting a common means of spreading the disease.

Cattle, sheep, goats and horses are highly susceptible and often affected; anthrax causes much loss among elephants in some districts; camels not infrequently die of it; swine are more resistant but are also attacked; dogs are highly resistant but outbreaks have been observed among packs of hounds taken over the country strewn with infected carcases. Human beings become affected with it very seriously usually when the infection penetrates a wound while skinning a diseased carcase and the acute local inflammation or boil that develops is known as "malignant pustule"; they may also become affected with a fatal lung trouble in sorting the wool or hair taken from the skin of animals dead of the disease when it is generally known as 'wool sorters disease'.

Etiology.—Anthrax is caused by a germ—*B. Anthracis*—which multiplies rapidly within the blood vessels or in inflamed tissues and as illness lasts only a short time—often only a few hours—symptoms are often not observed and the affected animal is merely found dead. The finding of a beast suddenly dead from some unknown cause should, therefore, lead to a suspicion of anthrax and the only certain means of ascertaining the existence of the disease is examination of a minute quantity of blood taken from the carcase. This can only be done by a professional man. What he does is to take a little blood from the ear vein for examination under a microscope for the presence of anthrax germs which are usually seen in enormous numbers in blood taken from a fresh carcase.

The microscopic organism causing anthrax—*B. Anthracis*—is cylindrical or rod-like in form, measuring 1/5000 inch to 1/2500 inch in length and 1/25000 inch in diameter. Like all bacteria these rod-like bodies have the power of enormous multiplication and in the bodies of infected animals, they cause death by rapidly increasing in numbers and producing substances which poison the body.

Anthrax differs somewhat in its mode of spread from other contagious diseases. Infection is always derived from a previously diseased animal and as will be readily understood, large quantities

of infectious material are scattered on the ground when an infected carcase is skinned and blood allowed to escape infection also escapes with the blood in the dung before and after death and the carcase becomes blown up or tympanitic after death and a blood-stained discharge escapes from the anus. At or near the temperature of the body the germs in a few hours change into very resistant seeds or "spores" as they are called. The capacity of these spores for remaining alive is so great that they have been found in the ground for periods extending thirteen years after the death of the animal from the disease, on the spot. In the unopened carcases, the germs cannot form resistant spores or seeds, and soon perish, for they require air for this process, hence the advantage of early and deep burial of all animals that die from the disease.

Healthy animals may therefore pick up infection in a place a long time after an animal had died there from the disease. Certain areas of land are known to be very dangerous, and hay (or other fodder) obtained from these areas is likely to carry infection. In particular, grass lands bordering upon water courses or tank bunds and flooded during the wet season have sometimes a bad reputation, and it is then found that this danger has risen from the practice of throwing the carcases of dead animals into the water courses.

The hides taken from the diseased animals are very dangerous, and so are the bones converted into bonemeal for manure unless they are properly disinfected.

The course of disease is very rapid, in fact the affected animal is merely seen dead ; but, had it been possible to observe it from the commencement of the illness, the following symptoms would be seen. High fever 106–107° F., with severe congestion of the visible membranes of the eyes and mouth, severe abdominal pain, with evacuation of fluid dung often blood stained, urine sometimes blood stained also, swellings may appear on different parts of the body (especially in cases that last somewhat longer) and they are generally diffuse and not painful or hot, sometimes great excitement followed by stupor, breathing difficult, the animal finally staggers, falls and dies in convulsions. In the case of horses and swine the symptoms last longer, and swellings in and around the throat are often seen with enlargement of the lymphatic glands.

Generally three forms of the disease are recognized, the first, the paracute, or the apoplectic form, the second, the acute or the splenic form, and the third, the sub-acute or the carbuncular form, and in the last stages, in all types, the most pronounced symptoms are identical.

Post-mortem Appearance.—Carcase usually much swollen and putrefaction sets in early, resulting in a very disagreeable odour from the carcase an hour or so after death. A gelatinous exudate is generally to be found under the skin, particularly in the neck and where there are any swellings. Blood dark-coloured, "Tarry" and thick. Muscles flabby and spotted with blood extravasation. Internal organs congested and contain blood spots. Connective tissues mostly infiltrated with gelatinous exudate. Lungs engorged with blood and trachea and bronchi contain frothy blood-stained discharge. Spleen invariably greatly enlarged, much softer than normal, and may be ruptured. The state of the spleen is very characteristic, hence the name 'splenic fever'. In horses and hogs the spleen shows a normal appearance, but the lymph glands of the throat and intestines show a swollen ulcerated condition.

Treatment.—Medicinal treatment of anthrax in animals has not proved satisfactory. Good results have been obtained from the use of anti-anthrax serum given in large quantities, at the very early stage of the disease either under the skin, or through the vein. It is not likely that opportunities for doing this will be afforded in affected cattle, but it is known to be an effectual proceeding for the treatment of men suffering from 'malignant pustule'.

Prevention.—Carcases of animals dead of anthrax or suspected to be dead of anthrax should not be skinned or opened on any account whatsoever. The local veterinary officer should be summoned with all possible speed to make a diagnosis on suspicion that death has occurred from anthrax, and to give professional directions for limiting the spread of the disease if a positive diagnosis is made.

If a veterinary officer is not readily accessible the owner should arrange to dispose of the carcase forthwith, for the most important undertaking in preventing the spread of anthrax is prompt disposal of carcases. The carcase in case of suspicious death ought to be burnt (the weight of fuel required is about equal to that of the carcase)

or buried at a depth of at least six feet from the surface of the soil, and it is advisable to cover the carcase with quicklime (its own weight) especially to prevent digging up by wild animals or chamars.

All discharges, manure, accoutrements from the animal should be burnt or buried at the same time, and a layer of soil six inches in depth soiled by the dead animal, thrown in likewise. The flame of a lamp or painter's lamp should be used liberally on the surface of stable walls, partitions, vehicles, and any other objects likely to have been soiled with the discharges of the dead animals. A most dangerous proceeding is to throw the carcase or incompletely burnt carcases, or any portion of it into water courses. Care should be taken to prevent access to dogs, wild animals or human beings before the carcase has thus been properly rendered harmless.

Preventive Vaccines.—In studies of some of the various infectious diseases it has been found that one of the most practical means of preventing their extension is to furnish the susceptible and exposed animals with artificial protection against the disease. This is the case with Rinderpest, Blackquarter and Hæmorrhagic Septicæmia, Anthrax and the like.

The successful vaccination of cattle against any of these infectious diseases strengthens the body tissues in such a way that no greater number of germs can find lodgement and nurture there. After such a vaccination the animal is fully protected and can go with perfect safety into localities that would have been deadly before the vaccination was performed.

Vaccination against anthrax is the oldest rational form of treatment of cattle and sheep, and is very widely employed in several other countries. Pasteur by his classical experiments was the first to demonstrate the safety and efficacy of vaccination against anthrax.

A useful serum is now prepared for employment by the veterinary authorities in the inoculation of all healthy cattle in herds or villages where anthrax has been diagnosed, and has shown a tendency to spread rapidly by attacking a number of animals in quick succession; although the immunity conferred by the serum is a short-lived one, only for a fortnight or so, the outbreak is quickly cut short.

But, in certain localities where there is a persistent recurrence of the disease, taking an annual toll, vaccination is practised to confer

a longer and lasting immunity. The vaccine commonly employed is composed of living anthrax germs much degraded in virulence by cultivation, under unfavourable conditions, so that a dose on injection will hardly kill a bigger animal than a mouse, but after inoculation into cattle will provoke them to react so that they develop a lasting immunity for about a year or more. This is known as sero-vaccination or spore vaccination.

The officers of the Civil Veterinary Department have been successfully protecting animals against the disease both by the spore vaccine and serum vaccine method, and will be glad to render all necessary help to stock owners.

SELECTIONS.

Honey as a Medicine

"During the current year we have extracted from home and foreign journals many medical opinions on the value of honey," says the *Scottish Farmer*. "We will conclude the series with one by Dr. E. Wagner as published in the best known German bee paper, *Die Biene*. 'Honey is a very ancient popular remedy whose beneficent action is derived from the poisons of the bees which it contains. Its activity is precious against bronchial catarrhs, gastric catarrhs, hoarseness, asthma, obstinate coughs, diphtheria, anæmia, illnesses of change of life, wounds of every kind, inflammation of the eyes, scarlatina angina, abscesses, maladies of the bladder, for every throat affection, inflammation of the pericardium, maladies of the heart in a particular manner, infections of the mouth, inflammations of the gums and conjunctival tissues, erysipelas, redness and inflammation of the skin and sores of the hands. For the cure of internal ailments it suffices to dissolve a small spoonful of honey in a glass of water and sip this in little doses during the day. For external affections the honey is applied direct by being spread out thin on a piece of lint. In cases of diphtheria it is taken non-diluted with the juice of lemon with a view to killing the infective bacteria. In all other cases it should be taken diluted. Thus very many maladies can be cured effectively and economically and even avoided by the rational use of honey.' "—*The Veterinary Record*, Vol. XI, No. 52.

Agriculture and Economic Depression

We extract the following paragraphs from the Report of the Work of the Bureau of Agricultural Economics of the Department of Agriculture, U.S.A., for the year ended June 30, 1931:—

"Agriculture has felt this last year the full impact of the world-wide economic depression. Prices for farm products have declined drastically and in some instances have gone below previous bottom prices. Prices of commodities that farmers buy have also declined, but not in a corresponding degree. Taxes, furthermore, have remained at peak levels, and debts have yielded grudgingly in the face of dwindling farm incomes. As the causes of the present situation are many, so are the

avenues of solution. It is a situation that calls for far-reaching adjustment in production and marketing, in credit, taxation, land utilization, and in State and National policies affecting agriculture. It is a situation that requires action by the farmer, the business man, and by National and State Governments. Some of these adjustments may be made more or less promptly, others only more gradually.

"As a basis for action there must be adequate information for effective planning. The current facts of production, demand, distribution, and the like are indispensable, but much more is needed. The meaning of such facts must be ascertained and used as a guide to action. Much of the farmer's present plight grows out of past failures to understand the trends of the times and to avoid pitfalls. Continuous adjustments in the light of adequate information give promise of materially improving present conditions and of preventing their recurrence."

Artificial Production of Rain

Two American scientists, Profs. Warren and Bancroft, have successfully produced rain in a series of experiments based on the natural process which takes place in the upper atmosphere. In the upper atmosphere moisture is always present in the form of minute drops so light that they remain in suspension. When particles of dust come in contact with the drops of moisture they are absorbed, thus increasing the weight of the drops. As a result of their electric charge (positive or negative) the particles tend to become aggregated into masses, too heavy to remain in suspension and then fall as rain. Thus clouds formed of vapour, too light to fall as rain, may be artificially weighted by electrically charged dust and immediate rain produced.

Acting on this theory a load of electrically charged sand was dropped from captive balloons on to clouds. Rain fell immediately.

Prof. Bancroft calculates that 40 lbs. of electrified sand would be sufficient to dissolve into rain one square mile of clouds.

In subsequent experiments an aeroplane was used carrying sand with a charge, partly positive and partly negative, of 12,000 volts. The machine rose and disappeared among the clouds while spectators below awaited the miracle, which proved even more dramatic than before. The clouds burst in a violent shower of rain, while at the same time the sky cleared and the sun shone again.

In the Netherlands Prof. Veraat has succeeded in producing rain over an area of about 8 sq. km. by a similar method, throwing finely divided dry 'ice,' *i.e.*, solid CO_2, from an aeroplane on to clouds. Similar

experiments had been tried previously by various scientists using pow dered Kaolin, but had not given satisfactory results.

Prof. Veraat rose to a height of 2,500 metres in an aeroplane carrying $1\frac{1}{2}$ tons of 'dry ice' and fitted with a special spreading apparatus; he then let the powder fall on to clouds 200 metres below. Abundant rain immediately fell. The experiment was officially controlled by observers in 4 military aeroplanes.

Prof. Veraat explains the formation of rain by supposing that during the fall from the aeroplane to the clouds the particles of solid CO_2 become electrically charged and transformed into microscopic drops of liquid CO_2, which cause condensation in the clouds and consequently a fall of rain.

According to Prof. Veraat this method will also make it possible to ensure fine weather when desired. By converting the clouds into rain early in the day he holds that a clear sky may be assured in a given locality for the rest of the day. (*La Meteorologia Practica*, 1931, Anno XII, No. 5, pp. 256–58.)—*International Review of Agriculture*, Year XXIII, No. 2.

Toxicity of Root Excretions

From ancient times the belief has persisted that certain species of plants may give off through their roots excretions which are toxic to the roots of other plants. Although the evidence for this idea has never been very strong it has been kept alive in the literature by occasional observations and investigation of alleged cases of the phenomenon. Pickering's studies of the influence of grass roots upon the behaviour of the apple are well known. The discovery of dihydroxy-stearic acid in wheat-sick soils was at one time interpreted as a case of toxic excretion. More recently Fletcher reported the extreme sensitivity of *Sesamum indicum* to the root excretions of *Andropogon sorghum* (*Sorghum vulgare*), and Sewell found that the roots of *A. sorghum* injured succeeding crops of wheat. He was able to obtain an extract from the soil in which the *Sorghum* was growing which was toxic to the wheat plant if the extract were prevented from becoming oxidized.

In some of these cases the alleged toxicity has been reinterpreted in terms of competition of root systems for nutrients such as nitrogen in the soil; in others, the toxicity can be interpreted in terms of the products of root decay in the soil. The case of *Sesamum indicum* mentioned by Fletcher, seemed very extraordinary. His photographs

indicate the profound effect upon the growth of *Sesamum*, and he concludes that *Sesamum* cannot grow to maturity within twenty inches of *A. sorghum*. It is practically certain that not all of the influential factors were under control in Fletcher's field tests, if indeed any of them were. But the stunted growth was so remarkable that the writer had long desired to see the results of the *Sorghum* root excretions upon the *Sesamum* plant. The opportunity to make such studies was not presented until very recently. Through the courtesy of Prof. G. S. Kulkarni, and Prof. V. G. Gokhale, of the Agricultural College, Poona, India, seeds of five varieties of the Indian jowar (*S. vulgare*) were obtained (Bedari, Fulgar, Gidgap, Maldandi and Perio), as well as seeds of both the white and black seeded varieties of *Sesamum indicum*.

These seeds were first grown in pot cultures in the greenhouses of the Oregon State College during the spring of 1931. Each of the varieties of *Sorghum*, and the two varieties of *Sesamum*, were grown alone as controls. There were five experimental cultures in which each variety of *Sorghum* was grown along with black sesame, and five in which white sesame accompanied the sorghums.

The soil used was a light sandy mixture which proved to be too light for very vigorous growth, but in every case the variety of *Sorghum* grew in association with the *Sesamum* plants, without causing any apparent injury to the latter. At the end of about nine weeks the pots were examined for root growth. It was found that the roots of the *Sorghum* and *Sesamum* plants were growing together most intimately without the slightest sign of abnormality of root development in the *Sesamum*. There was nothing to suggest any toxic action on the part of the *A. sorghum* roots.

After returning to the University of Chicago, a bed of *Sorghum* and *Sesamum* was planted about July 1, 1931, in one of the ground-level beds of the Botany greenhouses. Five rows of *Sorghum*, one of each variety, were planted about 16 inches apart, running north and south. Between each two rows of *Sorghum* was planted a row of *Sesamum indicum*, white or black, two rows of each being used. These were planted thus about 8 inches from the sorghums. The seeds germinated very promptly and the plants grew luxuriantly in the closest association. Figure 1 shows a photograph of the plants when about half grown. There were no indications of toxicity of the roots of *A. sorghum* (*S. vulgare*) for the roots of *Sesamum indicum*. The plants continued to grow until they reached the blooming stage together during the first week in October. Plants of both species were blossoming

normally within 8 inches of each other. The sorghums at their best were over 3 metres tall, and the sesame plants more than a metre tall. It was necessary to thin the sorghums to prevent shading of the sesame plants, and to remedy lodging of the sorghums from low light intensity which was aggravated by the thick planting.

The results failed entirely to confirm the alleged toxicity of the sorghums for *S. indicum*. Whatever the behaviour of these plants may be under the usual cultural conditions, and the edaphic and climatic conditions of India, in these green house experiments there was no evidence of the toxicity of root excretions of *A. sorghum*. The results obtained tend to make one sceptical as to the reality of toxic root excretions emanating from the root systems of living plants. The burden of proof should surely rest with those who make the claim that such toxic excretions exist.—CHARLES A. SHULL, *University of Chicago. Plant Physiology*, Vol. 7, No. 2.

Conservation of Grass in Transportable Form.—Grass Cakes

The following is an abstract from an article on "Pasture Research" by H. E. Woodman, M.A., Ph.D., D.Sc., School of Agriculture, Cambridge University, which was published in Volume No. 12, of *Tropical Agriculture* :—

"A future generation may witness the utilization of large areas of grassland for the sole purpose of production of protein concentrate. Pastures, having the appearance of vast lawns, may be cut over regularly and frequently throughout the growing season the nutritious, protein-rich produce being preserved for feeding to animals in winter confinement, along with balancing home-grown feeding stuff like meadow hay, cereals and roots. The mode of preservation may either be artificial drying, followed by pressing into cakes or grinding to the roughly powdered form, or it may consist in ensiling the freshly cut grass.

"During the 1927 season, Imperial Chemical Industries, Ltd., collaborating with the School of Agriculture, undertook the systematic cutting of some acres of grassland in the vicinity of their factory at Billingham. The cutting was so regulated that the herbage was always taken in its young leafy condition. Soon after cutting, grass was dried down in steam-heated troughs, and later the dried product was compressed into cakes by Hydraulic presses. These dried grass cakes measured 6 inches by 5 inches by 1 inch, and were of such a density that 40 cubic feet of the compressed material weighed 1 ton. They had kept the green colour of the fresh grass and had a pleasant fragrant smell. They contained 8 per cent moisture and 25 per cent of protein. When

moistened with water they swelled up considerably and disintegrated. Sheeps, bullocks and dairy cows ate them eagerly, both in their dry and soaked conditions. It is of interest to record that samples of these dried grass cakes have been kept for more than two years in an open box under laboratory conditions without displaying any deterioration whatsoever in respect of colour and smell. Their moisture content is still in the neighbourhood of 8 per cent.

"Critical feeding tests on these dried grass cakes were made at Cambridge, and two main conclusions were drawn: (1) The process of drying will not in any way impair the high nutritive properties of the fresh grass. (2) The dried grass cakes can successfully replace oil-cakes in the winter rations of dairy cows and fatten bullocks. It is possible to hope, therefore, that dried grass cakes will shortly find their way on the agricultural market and be used as a substitute for oilcakes in winter rations of farm animals. The problem of devising suitable appliances for cutting and drying down young grass is being studied by the Imperial Chemical Industries, Ltd., who are looking forward to placing the process on a commercial footing during the season of 1930.

"The advantages of such a side line in grassland husbandry are manifold:—(1) Dried grass cake is an almost ideal concentrated food for farm stock. It is highly digestible and is rich in protein, lime, potash, phosphate, vitamins and plant pigments. Pasture grass conservation implies a twelve, instead of a five months pasture season. (2) On the basis of the 1928 winter prices, 1 ton of dried grass cake would be worth £9 15*s*. for its feeding value alone. It would also have a high manurial value of about 27*s*. per ton, compared with linseed cake at 31*s*. and maize meal at 11*s*. per ton. (3) The advantages of such a system of grass conservation during war time are so obvious as to need no emphasis. During the Great War, one of the most acute problems was to find protein concentrates for farm animals. This difficulty need never arise again, since now it is recognized that the farmer's best protein concentrated food can be grown on his farm. Further, the system enables the cuttings from playing fields and sports fields to be usefully conserved. (4) Grass conservation should prove an incalculable boon to droughty parts of the empire like Australia, where the herbage shrivels away to nothing during bad seasons and thousands of sheep perish miserably. Why should not the irrigation areas of Australia be used for the intensive growth of young grass to be continually dried and pressed into cakes for transport to less fortunate droughty regions? Grass cakes will keep for years and are an ideal form for storage and transport. The day may be envisaged when they will be transported between colony and colony and favoured

regions will produce them for transport to the more needy parts of the Empire. (5) By grass conservation it will be possible to augment very considerably the availing supplies of concentrated feeding stuffs, the short of which present not only prevents the attainment of an all-round standard of intensive animal husbandry in Great Britain, but also causes the high prices of ruling for oil-cakes and cereal foods.

"It is clear that the artificial drying of young grass must always remain an industrial, or semi-industrial process. For that reason the method of ensilage is likely to make a more direct appeal to the farmer. It is of interest to record that satisfactory tests have been carried out in this connection at Cambridge. Three small soils were filled respectively with grass cuttings from certain college playing field; with a mixture of grass cuttings and dried sugar beet pulp; with a mixture of grass cuttings and oat straw chaff. The results were satisfactory in every case, the silage being readily eaten by stock. This side of the problem of the grass conservation, however, is being studied further at the present time."—*The Cyprus Agricultural Journal*, Vol. XXV, Part III.

Management of Farmyard Manure

By H. V. Garner, M.A., B.Sc.,
Rothamsted Experimental Station.

Those who are interested in the development and extended use of chemical fertilizers sometimes overlook the importance of farmyard manure in maintaining the fertility of our soils. How considerable this is may be seen by assessing the respective contributions of dung and artificials to an arable rotation in which fertilizers are used in ordinary amounts.

Manuring of a Five-Course Rotation.

	Farmyard manure Tons	Sulphate of ammonia cwt.	Super-phosphate cwt.	Muriate of potash cwt.
Roots (potatoes, beet) ..	12	2	3	2
Barley ..	..	..	..	..
Clover ..	..	..	2	½
Wheat ..	..	..	..	..
Oats ..	..	1	1	½
Total ..	12	3	6	3

From the composition of the manures and the quantities used the following table may be derived:—

Lb. Per Acre Per Rotation.

	Nitrogen total	Nitrogen available	Phosphoric acid	Potash
From Dung ..	166	53	70	193
From Artificials ..	70	70	108	168
Total ..	236	123	178	361

In the above instance, the farmyard manure provides at least 70 per cent of the total nitrogen, 43 per cent of the available nitrogen, 39 per cent of the phosphate, and 53 per cent of potash. There is no doubt that, in general, the part played by dung is considerably greater than this, for, on a large number of holdings, more dung and less artificials will be used per acre. An estimate, made in Denmark in 1929, shows the outstanding importance of farmyard manure in a country that also consumes large quantities of artificial fertilizers. The dung was found to account for 84 per cent of the total nitrogen, 54 per cent of the phosphoric acid, and 90 per cent of the potash used on Danish farms.

It is, perhaps, surprising that, in spite of the great importance of farmyard manure, it has been the subject of comparatively little experimental work. Many experiments compare the action of dung with artificials, in some cases over several seasons, but few exhaustive experiments have been designed to compare the field results obtained with dung made, stored or applied in different ways.

The best-known British experiments on these lines are those carried out by Professor Berry at the West of Scotland Agricultural College in the years preceding 1914. At Rothamsted, also, in 1915–16, the losses of nitrogen under different systems of management, and the effect of the various manures on the first and second crops, were ascertained.

Recently, the results of a long series of classical experiments carried out during the period 1911–26 at Aarslev, in Denmark, have been made available and a few notes on the arrangement and the main conclusions of this work may be of interest.

Two lots of dairy cows were fed on an equal ration of bulky fodder, one lot receiving ordinary cake feeding and the other heavy cake feeding. A strict account was kept of the quantities of food and litter used, and

of the milk, urine and dung produced, as well as their composition in terms of nitrogen, phosphoric acid and potash. Arrangements were made in each case for separating the liquid manure from the dung and litter and collecting it in tanks, this being the common practice in Denmark. The dung was made and stored in different ways and used in replicated series of rotation experiments on arable crops. The results were, therefore, measured in terms of the composition of the manure as well as by its crop-producing power over a series of crops. In every case, the dung and corresponding liquid manure were applied to the crops. Under the ordinary system of management, where about 2 lbs. of litter per head per day was used, and almost all the urine was conducted to the tank, the loss of nitrogen from the solid manure was quite small, being only about 7 per cent.

Experiments with various quantities and types of litter showed that increasing the litter from 2 lbs. to 11 lbs. of straw increased the loss of nitrogen from the solid manure. This loss was further increased to 27 per cent by allowing the liquid manure to percolate through the dung before draining off into the tank.

The addition of peat moss litter also increased the loss of nitrogen from the solid manure. In fact, any process that caused the liquid to be held up in the straw and dung instead of getting straight away into the storage tank was inferior to the standard practice. The loss of nitrogen was reflected in lower yields in the field. The conclusion was that only sufficient straw should be used for the comfort of the animals. If new straw, instead of being used as extra litter, was applied along with the dung in the field, considerable loss of crop resulted, an effect that has often been observed elsewhere.

Storage of the solid manure in loose and compact heaps showed that the loose heaps became hotter and lost more nitrogen, but the difference in crop-producing power between the two types of manure was, if anything, in favour of the loose-stored material.

Manure stored in the open gave as good results as that stored under cover, but lost rather more nitrogen. The advantage of covering the manure is that the drainings can be utilized, since they are not too dilute to handle.

In considering these results it must be borne in mind that the Danish system secures the most valuable part of the manure separately, and the remainder, being much more stable, is subject to quite small losses and can even stand looseness and exposure without coming to much harm.

In the British system, the litter holds much more of the liquid manure and consequently the losses are higher, but may be reduced by the plentiful use of litter and compacting the moss.

The paper is full of useful chemical data relating to the composition of manure, urine, drainings from dung heaps, etc., and the distribution of nitrogen between dung, milk, urine, and live-weight increases.—*The Journal of the Ministry of Agriculture*, Vol. XXXVIII, No. 12.

Vegetative Propagation

A fresh plant may generally be raised by two methods: from seed, or from some fragment of a parent plant other than a seed, or as in budded seedling stock, by a combination of both methods. Seed propagation involves a sexual act, and produces a definitely new individual which may or may not closely resemble the parent type. In most orchard crops, the offspring usually shows considerable variation. Vegetative propagation is not a sexual process and does not produce a new type; it merely extends the original parent type.

Considerable advantage has been taken of vegetative propagation with temperate orchard crops, and there is every reason to anticipate that a wider application of such methods to tropical crops would prove of advantage. The realization of this will depend primarily on the discovery of methods of vegetative propagation suitable to commercial application, and secondly, in the interest shown by planters in the use of vegetatively raised stock.

The practical classification of methods of vegetative propagation may be made into:—

(1) Rooting process, and

(2) Grafting process.

The first group of methods aims at the production of new roots and shoots upon plant parts such as stems, roots, or even leaves, the new root and shoot system being eventually established as a new plant. This group may be further sub-divided according to whether the new roots are formed while the organ is still retained on the parent plant, or after it has been removed as a cutting.

Thus there are:—

(1) Layering, stooling and allied processes such as "bagging" or "marcotting".

(2) Cuttings, which may be either hardwood or softwood stem cuttings, root cuttings or leaf cuttings.

The second main group consists of the method of grafting, budding and approaching grafting, sometimes collected under the general term

"graftage". There are many modifications of practical methods, but the basic principle is always that of inducing the tissues of two separate plants to grow together, in order to form one composite plant. In grafting or budding, a part of one plant, either a small piece of stem or a piece of bark including a bud, is removed and placed in contact with the cambial tissue of the other plant so that the tissues grow together. In approaching grafting, two plants are made to grow together while each is still on its own roots, by removing the bark from portions of the stems to expose the cambium and binding the two stems together with the bared surfaces in contact.

Advantages.

The advantages of vegetative propagation are as follows :—

(*a*) *Uniformity.*—The extension of a type by vegetative propagation makes possible a degree of crop uniformity, both of yield and of quality, which is rarely attained in a seedling population. This uniformity is of great advantage both in the scientific and the commercial fields. In scientific works a high intrinsic variability in the experimental material obscures the variability caused by the experimental conditions ; for the grower the presence of low yielding types increases the overhead costs of the plantation.

The root stock upon which a variety is budded often has a marked influence upon the yielding capacity of the scion. If uniform yielding material is required, the variety must either be established on its own roots by root cuttings or stool shoots or else it must be budded on to a clonal root-stock. Only if the root system is clonal can a reasonable uniformity of yield be obtained.

(*b*) *Extension of Environmental Range of a Crop.*—The isolation of individual plants, chosen for special qualities, such as cold or drought tolerance, and their subsequent vegetative propagation can increase the range of cultivation of a crop by bringing in districts which are unsuited to the average type. This is analogous to the breeding of hardy strains of wheat, when however, vegetative propagation is not necessary to fix a type, as pure genetic lines are readily raised.

(*c*) *Increase of Vigour of Weakly Types by working on to Suitable Clonal Root-Stocks.*—In temperate horticulture it is a standard practice to work certain varieties on to vigorous stocks, thus improving either their vegetative growth or cropping capacity, or both. In tropical crops, modern breeding work will probably produce delicate varieties which require the assistance of hardy root-stock.

(*d*) *Propagation of Sterile Types.*—Some desirable fruit varieties such as seedless oranges, grapefruit and sapodillas, are highly sterile

and thus cannot be propagated by seed. In these fruits, vegetative propagation must be used to extend the variety.

(*e*) *Early Maturity.*—A bud from a seedling may often be made to grow and bear fruit sooner than the original seedling, by working it on to a stock. This hastening of maturity would be of great value in speeding up genetic work on an orchard crop.

DISADVANTAGES.

(*a*) *Initial Cost.*—The first cost of a vegetatively raised nursery plant will usually be higher than that of a seedling planted at stake. However, the increased yield expected from such nursery plants should amply justify the initial increased expenditure.

(*b*) *The Root System.*—A tap-root is by definition an organ peculiar to a seedling. However, exactly similar functioning roots can grow on vegetatively raised plants. It is highly probable that in most orchard crops, after a certain age, the root systems of trees which grew from seedling root-stocks and those which grew from vegetative root-stocks will be found to be indistinguishable. Even in seedlings it is doubtful whether the primary tap-root is persistent in a mature tree.

(*c*) *Senescence and Degeneration.*—Does continued vegetative propagation necessarily result in any lack of vigour, either vegetative or sexual, in the plant? The question of senescence always arises in connection with the vegetative extension of varieties. At the present day, the occurrence of true senescence in clones on continued vegetative propagation is neither proved nor disproved. However, even if some senescence were proved to occur, it would not effect very much the policy of orchard crop growers, who normally would wish to plant new varieties from time to time rather than to replant with old varieties which would have begun to wane in popular favour.

There is, however, the problem of contamination of clonal varieties by rogue plants, either of seedling or clonal origin, or by diseased plants. This contamination may materially reduce the yield from a plantation and give the impression of senile change, or "running-out", in variety. The solution must lie in the prevention of the propagation of rogue types by care in taking bud-wood or cuttings and by vigilance in the nursery.

(*d*) *Problems of Sterility within a Clone and between Clones.*—Self-sterility occurs in many varieties of fruit crops. Even different varieties may not be sufficiently cross-fertile to ensure sufficient setting. Some edible fruits develop with a low percentage of ovules fertilized, and in these, high degrees of sterility occur without affecting yield. In a seed crop, however, a high percentage of ovules must be fertilized as seed is rarely produced without fertilization. In such crops, therefore, pre-

cautions must be taken against sterility by planting mutually cross-fertile varieties together.—*The Malayan Agricultural Journal*, Vol. XX, No. 3.

Indian Sugar Industry in 1930-31

Sugar (Rs. 10,96 lakhs).—The sugar industry had another bad year and the position was so critical that an international conference of producers from the chief producing countries was held in Brussels in December 1930 to devise some remedy to combat the depression. A Committee of the League of Nations had also reviewed the sugar position in 1929. These frequent investigations by international agencies show the chronic depressed condition of the world sugar industry. The main cause for this depression is, as in the case of many primary products, the excess of supply as compared with effective demand. The excess in production was due to the peculiar circumstances of the immediate post-war period when on account of the shortage of beet sugar during the War large areas of new land were brought under cane, especially in Cuba. When the production of beet sugar started again this additional supply of cane sugar exerted a steadily depressing effect on the market. Another factor which also led to over-production was the introduction of new methods in the breeding of sugarcane especially the growing of the POJ 2878 variety in Java which has greatly increased the yield of sugar there. Further, the protectionist policies of the various countries devised to encourage the production of home-grown sugar aggravated the situation. All these factors exerted a depressing influence on the sugar market in the last few years. It has been estimated that the production of beet sugar increased from 9.2 million metric tons (raw value) in 1927–28 to 11.7 million metric tons in 1930–31, an increase of 2.5 million metric tons. In the same period the cane sugar production went up from 17.5 million metric tons (raw value) to 19.1 million metric tons in 1929–30 and 18 million metric tons in 1930–31. Thus the total production of sugar in the world increased from 26.97 million metric tons in 1927–28 to 29.7 million metric tons in 1930–31, an increase of 3 million metric tons. For the same period, however, consumption did not increase to the same extent in spite of the great fall in prices. It has been estimated that the consumption for 1927–28 was 26.4 million metric tons in terms of raw sugar. In 1929-30, the latest year for which figures are available, the consumption has been estimated at 27 million metric tons, an increase of only 0.6 million metric tons as compared with an increase in production of 3 million metric tons. As a result of this disparity, the stocks of sugar were mounting up considerably. In 1927–28 the stocks were estimated at 3.2 million metric tons. In 1929–30 they

had gone up to 5.1 million metric tons. This dead-weight of stocks and the steadily increasing production have been responsible for the depression in the sugar market in the last few years. In order to remedy this situation the international conference which met in December 1930 formulated a scheme which fixes the export quotas for the chief sugar-exporting countries. The provisional terms of agreement also provide for the disposal of the stocks in hand on 1st September 1930 at a certain rate per annum. This scheme had, however, little tangible effect on sugar prices in 1930–31.

The heavy production of the year, as given above, depressed the prices of sugar almost throughout the year. In India the problem was aggravated by the slump in silver prices which by disturbing the normal trade relations between Java and China, the most important of the outlets for Java sugar outside India, helped to throw the bulk of the Java sugar on the Indian markets. This drove prices to unremunerative levels, so that the sugar producer in India was very adversely affected. Even the increase in the revenue duty of Rs. 1–8–0 per cwt. under the Finance Act of 1930 did not materially raise the sugar prices in India. In May 1930, therefore, the Government of India, acting on the representation of the Imperial Council of Agricultural Research and some of the provincial Governments, directed the Tariff Board to hold an enquiry into the question whether protection was required for the sugar industry in India. The report of the Tariff Board, issued towards the end of the year under review, recommended the grant of protection to the local industry for a period of fifteen years. The protective duty recommended was to be at the rate of Rs. 7–4–0 per cwt. for the first seven years and Rs. 6–4–0 for the remaining period. The Board further proposed that power should be taken to impose an additional duty of 8 annas per cwt. in the event of break-down in the international agreement for the stabilization of prices. The Tariff Board's recommendations for the protection of the sugar industry were under consideration when the year closed, but in raising the revenue duty on sugar of 23 D.S. and above to Rs. 7–4–0 and that on sugar between 8 and 22 D.S. to Rs. 6–12–0 per cwt. in the Budget of 1931–32 the Government of India took into account the fact that these rates corresponded to those recommended by the Tariff Board for protective purposes.

The unhealthy condition which continued to influence the world sugar industry during 1930–31 was abundantly reflected in the course of sugar prices in India, the general trend for the year being only a continuation of the same tendency as had been at work in the preceding year. Almost throughout the year prices of sugar, both in the Calcutta

and Bombay markets, were consistently on the decline. The quotation on the 4th April 1930 for Java 25 D.S. in Calcutta was Rs 9–1–9 per maund. After a nominal drop of 9 *p.* in the course of the next week the quotation moved upward to Rs. 9–3–6 on the 18th and after staying at this level till the 25th it dropped to Rs. 8–14–3 by the 23rd of May. This downward movement was initiated by reports regarding a dissolution of the Single Selling Agency in Cuba. Subsequently there was a considerable degree of steadiness which forced prices up to Rs. 9–1–6 by the 6th of June. In the next week the quotation slipped back to Rs. 8–14–6 but the market remained uncertain till the end of the month on account of the varying reactions produced by the reported scarcity of stocks in the local market and the expectation of imminent selling pressure in Java, to which was added an uncertain feeling produced by the bearish report about the beet crops of Europe. From the beginning of July the decline became more consistent when the Java Trust was reported to have lowered its limits for the new crop. After touching Rs. 8–10–3 by the 18th of July prices recovered to some extent, but the arrival of fresh supplies caused a bearish sentiment in the market to reassert itself. By the middle of August the downward trend in sugar prices commenced again. On the 5th of September prices dropped to Rs. 8–10–9 from Rs. 8–15–3 on the 15th of August. There was some recovery owing to seasonal factors, but subsequently prices again slumped to Rs. 8–11–6 on the 10th of October and then with slight oscillations prices gradually dropped to Rs. 8 on the 28th of November. During December, as a result of the reports regarding the Brussels Conference, the market gradually revived, prices rising from Rs. 8–3–0 on the 5th to Rs. 8–5–0 on the 19th. In January 1931 the course of prices was erratic owing to apprehensions created by the reported arrivals of Russian sugar and also owing to the uncertainty of the results of the international negotiations. From the end of the month, however, the quotation moved upward from Rs. 8–5–6 on the 30th of January to Rs. 9 on the 27th of February. This was in consequence of speculative purchases encouraged by anticipations of a rise in the customs duty from March. Subsequently when the actual increase in the customs duty was found to have been short of the trade expectations the heavy stocks accumulated in anticipation of the tariff increase tended to depress the market to some extent and the prices experienced a slight set back to Rs. 8-12-0 on the 6th of March; but the encouraging reports regarding the international negotiations created a steadier feeling in the market and raised the price to Rs. 8–15–0 on the 27th of March.

In the Bombay Market the quotation for Java white, granulated

T.M.O. quality, stood at Rs. 13 per cwt. on the 4th April 1930. Prices remained nearly at this level with slight oscillations of an anna or two on either side till the beginning of June. In that month, however, prices showed a rising tendency and by the first week of July the quotation had risen to Rs. 13–9–0. The succeeding weeks of July witnessed a relapse which carried prices down to Rs. 12–8–0 on the 25th. August started with an upward spurt to Rs. 12–13–0 recorded on the 1st. For the next three weeks the quotation was round about Rs. 12–12–0 and in the last week of the month prices again went up to Rs. 13–0–6 and remained almost at that level till the third week of September. In the last week of September, however, prices again declined, the quotation on the 26th being Rs. 12–10–0. From that date till the end of November prices were almost continually on the decline, the quotation on the 28th November being Rs. 11–11–0. In the first two weeks of December prices went up slightly and throughout the month they were on a comparatively higher level than in November. On January 2, 1931 the quotation was Rs. 12. After a slight relapse in the following week the quotation went on continually increasing till the end of February when the price record was Rs. 12–14–0. This was due to the anticipations of a higher duty in the Budget. March saw a relapse, as the Budget provision did not come up to the expectations of the market. The year closed with the quotation of Rs. 12–9–6 on the 27th March.

Imports of sugar of all sorts, excluding molasses, decreased from 940,000 tons in 1929–30 to 901,000 tons in 1930–31, the decline in value being from Rs. 15,51 lakhs to Rs. 10,54 lakhs. The decline in the imports of sugar was due, to some extent, to the falling-off of beet sugar imports from 131,000 tons to 78,000 tons. Imports of sugar 16 D.S. and above increased from 807,000 tons to 815,000 tons. The main increase was in the imports from Java which rose from 779,000 tons to 802,000 tons in the year under review. Imports from the United Kingdom of sugar 16 D.S. and above went down very considerably from 14,000 tons to a little over 1,250 tons. Imports from Ceylon increased by over 2,000 tons. Imports from China, including Hongkong, increased to 5,000 tons from 2,800 tons in the preceding year.

Imports of Java sugar into the different maritime provinces during 1930–31 were as follows:—

Bengal	..	324,900 tons	(353,200 tons)	or 40 per cent.
Bombay	..	177,000 ,,	(151,300 ,,)	,, 22 ,,
Sind	..	184,300 ,,	(156,600 ,,)	,, 23 ,,
Madras	..	77,400 ,,	(78,200 ,,)	,, 10 ,,
Burma	..	38,600 ,,	(40,800 ,,)	.. 5 ,,

(Previous year's figures are shown in brackets.)

The total amount of beet sugar imported during the year was 78,000 tons as compared with 131,000 tons in the preceding year. Imports from most of the countries declined. An interesting feature of the year, however, was the arrival of 42,600 tons from Russia which had no share in this trade during the two preceding years. The United Kingdom sent only 700 tons in the year under review as compared with 45,000 tons in the preceding year. The share of Hungary went down from 35,000 tons to a little under 14,000 tons and Germany sent 11,500 tons as compared with 13,700 tons in the preceding year. There were no imports from France and Austria. Imports from the Netherlands declined from 2,200 tons to 600 tons and those from Czechoslovakia and Serb-Croat Slovene State from 9,000 and 5,000 tons in 1929–30 to 500 and 50 tons, respectively, in the year under review. The bulk of the imports of beet sugar during the year was received in Sind and Bombay.

The following table gives the imports of sugar from the principal sources for a series of years :—

Imports of sugar, all kinds (excluding molasses).

	1913-14 (pre-war year)	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
United Kingdom.	900	6,300	9,200	400	4,800	59,300	8,400
Ceylon ..	100	1,300	2,100	2,800	4,000	3,600	5,700
Java ..	583,000	656,900	611,700	692,200	850,800	781,100	809,700
Mauritius ..	139,600	19,100	100	..	..	..	..
Straits Settlements ..	2,900	2,200	1,100	1,200	900	600	500
China and Hongkong ..	1,500	2,200	3,100	3,100	2,100	6,100	5,100
Egypt ..	100	300	..	..	..	..	..
Japan ..	100	..	..	100	300	500	..
Germany ..	700	1,500	49,200	1,600	300	15,200	11,700
Austria }	74,000	2,000	9,800	300	..	1,400	..
Hungary }		19,100	26,000	2,300	2,100	36,500	13,800
Netherlands ..	..	800	3,700	700	1,600	2,500	600
Belgium ..	..	6,800	13,800	400	300	1,800	300
France ..	..	100	200	..	800	11,900	..
Czechoslovakia ..	..	10,300	28,800	1,100	400	9,700	600
Italy ..	..	1,200	3,700	200	..	..	..
United States ..	..	2,100	15,500	500	200	200	200
Other Countries	100	400	48,900	18,900	200	9,200	44,600
Total All Countries	803,000	732,600	826,900	725,800	868,800	939,600	901,200
Value Rs. (lakhs)	14,29	15,20	18,36	14,50	15,86	15,51	10,54

In the chart on the opposite page (chart omitted) the prices of Cuban raw sugar at New York and the course of prices in Calcutta of sugar, all-cane, equal in colour to 25 D.S. and above are compared. At the beginning of April 1930 Cuban raw sugar was quoted at 1.84 cents per lb. By the end of May the quotation declined to 1.37 cents, and, although later prices behaved most erratically, the downward trend was maintained till 1.04 cents as touched at the beginning of October. During the subsequent months of the year the position improved, prices fluctuating mostly between 1.22 and 1.40 cents. The quotation at the end of the year was 1.35 cents.

The imports of molasses, almost wholly from Java, increased from 72,000 tons valued at Rs. 26 lakhs in 1929–30 to 102,000 tons valued at Rs. 42⅔ lakhs in 1930–31.

Re-exports of sugar from India decreased from 7,300 tons valued at Rs. 17 lakhs in 1929–30 to 3,400 tons valued at Rs. 6½ lakhs in 1930–31. The share of Kenya Colony (including Zanzibar and Pemba) was 1,000 tons as compared with 2,600 tons in the preceding year. The shares of most of the other countries fell considerably, except in the case of Persia which increased her takings to 600 tons as compared with 500 tons in the preceding year.

The total area under sugarcane in India was 2,778,000 acres in 1930–31. The total production of raw sugar, *gur*, was 3,177,000 tons as compared with 2,752,000 tons in 1929–30. The production of sugar by modern factories and refineries in the season 1929–30 amounted to 111,000 tons as compared with 99,000 tons in 1928–29 and 120,000 tons in 1927–28. Exports of Indian sugar during the year under review decreased from 1,300 tons to 1,000 tons, which included 500 tons of unrefined sugar. There was also a falling-off in the exports of molasses (including palmyra and cane jaggery) from 1,100 tons in 1929–30 to 500 tons in 1930–31 of which 400 tons (or 85 per cent) were despatched from Madras. Shipments to Ceylon amounted to 400 tons.—*Review of the Trade of India in* 1930–31, No. 2275.

By-Products of the Sugarcane Industry

The following paper was communicated by Mr. W. G. Freeman, B.Sc., A.R.C.S., F.L.S., of the Imperial Institute, to the Imperial Sugarcane Research Conference, held in London, July 1931, and is reproduced, by kind permission of the Controller, His Majesty's Stationery Office, from the *Proceedings* of the Conference, published January 1932 (price 2*s.* 6*d.*). A set comprising most of the by-products mentioned in the

paper has been placed on exhibition in the Public Galleries of the Imperial Institute.

The sugarcane is grown primarily as a source of crystallizable sugar. All the sugars present in the cane cannot, however, be obtained in crystallized form, but can in great part be recovered in the molasses. By fermentation of molasses a palatable alcoholic drink, rum, is obtained, and from very early days of sugarcane cultivation, molasses and rum have been well known as by-products. In some localities even to-day cane may be grown largely for a by-product, *e.g.*, rum, the production of commercial sugar being of minor importance.

The fibrous portion of the cane, left after extraction of the juice, and known as bagasse or megass, has always been of great importance as the fuel for the evaporation of the cane juice. It was all required on the estate and often had to be supplemented by other fuel, and so had no value as a saleable by-product. Recent developments, however, have caused bagasse to become, in some countries, of use for other purposes and thus to have a commercial value as a by-product. The molasses can be used for the preparation of other forms of alcohol than rum; also for the manufacture on a large scale of yeast and "dry-ice" (solid carbon dioxide).

With the low value now obtaining for the primary product—crystallized sugar—these by-products are becoming of increasing commercial importance.

The object of this paper is to give a brief summary of information relating to these various by-products. It has been based on a memorandum prepared by the Department of Scientific and Industrial Research in collaboration with the Imperial Institute in September 1930, with some additions.

The products dealt with and their origin are indicated in the following table:

Bagasse.—
- Paper.
- Artificial Silk.
- Fibre Board—Celotex and Vazcane.
- Feeding Stuffs.
- Explosives.
- Charcoal.

Molasses.—
- Rum.
- Power Alcohol.

Dry Ice (Solid Carbon Dioxide).
Alcohol, Glycerin, Acetaldehyde and Dry Ice (combined production).
Yeast.
Fuel.
Fertilizer.

Filter Press Cake.—
Wax.

Bagasse.

The primary use of the bagasse is as fuel for the purpose of boiling down the sugar-containing juice extracted from the cane. In early days it was necessary to dry the bagasse in the sun, but now it is usually fed direct from the mills to the furnaces. The fuel value of bagasse is low, but modern improvements in the design of furnaces have resulted in much economy and in many of the more efficient factories there is no longer any necessity to employ additional fuel. In fact, there is frequently a surplus of bagasse which is available for other purposes. This will vary with the season. Thus, in a dry season with canes yielding a juice rich in sucrose, less fuel is required than in a wet season when the juice is of low sucrose content.

Should it be possible to make profitable use of bagasse as a by-product, Dr. F. Maxwell has suggested that it might be worth while to reduce the amount of sugar extracted and increase the amount of bagasse available. Taking for example a typical large Cuban mill in which seven or eight milling units extract about 95 per cent of the available sugar, requiring about 2,500 horse-power, the first three units of the train will extract some 85 per cent of the sugar with an expenditure of about 1,000 horse-power. The units necessary to extract the final 10 per cent require 1,500 horse-power. He has, therefore, suggested that if these, or some of these, were closed down to give a lower but more economical extraction, the bagasse saved (otherwise used as fuel) would be rendered available for other purposes.

Another possibility is to alter our views of the ideal cane and breed for fibre and sugar content as is being done in Louisiana and Florida. As put by E. L. Squires :—"The cane production in the United States is being re-established on a sound basis with new varieties of cane, and a part of the production so called with the bagasse board industry that sugar will almost be a by-product of this synthetic lumber." Or again :—"Apparently bagasse is a very high-priced fuel and it might be better to burn the sugar."

There is also the possibility that in some countries some other fuel, *e.g.*, oil, might be available at sufficiently low cost to allow all or part of the bagasse being put to other uses.

Paper.

Dry bagasse contains about 40 to 50 per cent of cellulose and many years ago attempts were made to utilize the fibre for the manufacture of paper. The material produced suffered from the defects of bad colour and harsh "rattly" texture. The paper had a satisfactory tensile strength but rather low tearing resistance and was suitable only for a wrapping paper or as a mulch in sugarcane and pineapple cultivation.

Amongst recent trials may be mentioned one made by the Imperial Institute in 1929 with bagasse from Trinidad. The report states this sample "furnished a good yield of pulp which easily bleached and yielded paper of excellent strength, but exhibited the 'rattly' character of paper produced from fibrous material containing pithy matter. By mechanical separation of the pith from the fibrous material it would no doubt be possible to produce paper of very good quality." It is suggested that good paper might be made by a fractional digestion process as applied to bamboos, or a chlorination process used in making straw pulp.

Another point is that owing to the seasonal nature of cane crushing some means of storing bagasse is necessary in order to provide a continuous supply to a paper-making plant. Owing to the rapid deterioration of bagasse this presents some difficulty.

Various commerical projects have been started, *e.g.*, in Formosa, Hawaii and Cuba, but at present apparently very little, if any, bagasse is being used for the manufacture of paper. The question is, however, still being investigated by the Hawaiian Sugar Planters' Association.

Artificial Silk.

Bagasse is also a possible raw material for the preparation of artificial silk.

An examination of Trinidad bagasse for this purpose was made by the Imperial Institute in 1928. As for paper manufacture, the presence of pith is a defect, and this portion had to be removed as far as possible by rubbing and sieving, and by fractional digestion. The resulting material, about 40 per cent of the original bagasse, digested with caustic soda, yielded a fairly long-fibred pulp which bleached readily to a pale cream and when dry could be fairly easily disintegrated by hand. Tests of the pulp indicated that bagasse is suitable for producing pulp similar in chemical composition to the wood pulp employed

in the manufacture of artificial silk. Owing to the necessity for eliminating the useless pithy material the amount of pulp obtained represented only about 24 per cent of the original bagasse, whereas, on a commercial scale, spruce yields from about 45 to 50 per cent. of pulp.

Various processes have been patented for the manufacture of artificial silk from bagasse. In 1927 a company erected a plant in Cuba for the production of pulp for paper and artificial silk. The original capacity of the plant was stated to be about 120 tons of pulp a day. In 1928 it was reported that its capacity was being largely increased in order to cope with the demand. Since then activities have practically ceased, and there is as yet no evidence that commercial success has been attained in the utilization of bagasse for the preparation of cellulose on a large scale for artificial silk manufacture.

An interesting account of the position in Cuba was given by Joaquin de la Roza at the Fourth Annual Conference of the Association of Sugar Technologists of Cuba, 1930. The following is a summary:—

"When President Machado was presented last August with the first material to be made from the cellulose of bagasse, *viz.*, a pair of ladies' rayon hose, 'there came to a successful close a long chapter of basic research and development, and officially a new industry was born in Cuba'. Now α-cellulose can be made from bagasse in the form of white sheets which are used by the artificial silk manufacturer as raw material in competition with that made from cotton. It is very doubtful if the fibre of bagasse contains much more than 40 per cent. of α-cellulose, though β-, γ-, oxy- and other degraded celluloses may be present in greater or less proportion. Analytical methods used for its isolation from cane fibre consist of a series of mild chemical treatments designed to destroy or modify non-cellulosic substances; but it is obvious that such methods besides being impracticable are too expensive to be used for the commercial production of this material. Success in developing suitable technical processes have been due, says the writer, perhaps more to faith and necessity than to anything else. That is, faith in the fact that bagasse is the world's cheapest and most plentiful source of cellulose, and the necessity of developing commercially this product of our industry to enable it to meet the inroads of competition and adverse legislation.

"Since the author's first patents were filed in Cuba in 1925, the process developed in the laboratory has been transferred into a commercial reality on a very large scale. Conveying bagasse over long distances, for example, has been solved by blowing it through pipes of large diameter. Organic acids formed by the decomposition of sugar, said not

to attack iron and steel, were found to be corrosive, and monel metal had to be used. After several years of work, at the plant at Central Tuinicu, the technical difficulties were finally overcome and it was possible to produce a sufficient tonnage of 'Alpha Cellulose Cubana', containing an average of 97 per cent of the actual α-compound, for shipment to various mills in the United States for trial in large-scale demonstrations. These tests proved that the α-cellulose made in Cuba as a competitor to purified cotton linters has become an accomplished fact, so that 'the new industry Celulosa will soon be the support of its sick sister sucrose'. (Patents dealing with Cellulose, taken out by the author of this paper, have been noticed by us, *I.S.J.*, 1929, 107; 1930 221. One of these describes the following procedure: 'Preferably the fibre is crushed and washed in hot water before treatment with sulphurous acid, while the succeeding alkaline treatment may follow immediately, or later. Subsequent to the acid treatment, the fibre is washed in hot water and treated with a dilute solution of potassium or sodium hydroxide under pressure at from 140–170° C. It is finally washed and bleached. Alternatively, the alkali may be at atmospheric pressure, and below 100° C., the fibrous material being subsequently beaten in a pulping engine.'—Ed.)."

Fibre Board.

Celotex.—An application of bagasse which was started some ten years ago and has now reached considerable proportions is the manufacture of fibre board. The process is in the hands of the Celotex Company and is centred at Louisiana although factories have been proposed in other sugarcane producing countries. Work commenced on a small scale in 1920 and was operated commercially in 1922 when the output was 18 million sq. ft. of board. By replacing bagasse furnaces with suitable oil-burning equipment the boiler efficiency was increased from 55 per cent to 70 per cent, so that the cane crushers were able to dispose of the bagasse to the Celotex Company at a fair profit. The earliest difficulty encountered was the removal of the large quantity of bulky material produced during the short crushing season of 60 to 90 days and its storage for use throughout the year. Special heavy balers were designed producing bales of 200 lbs. to 250 lbs., which were piled by cranes in dumps 60 ft. by 100 ft. by 30 ft. high. Precautions against spontaneous combustion are essential and a chemical treatment is given to prevent decomposition. Retting by storage under water or in an atmosphere of carbon dioxide is also employed to reduce the fibre to a more workable condition. The material at the mill is subjected to beating, digestion and washing under carefully controlled conditions

until fibres of the requisite fineness and purity are obtained. The pulp of thin consistency is then supplied to the board-making machine, consisting of moulding rolls and presses, from which emerges a continuous sheet of board containing about 50 per cent of water, which is removed in drying ovens several hundred feet long maintained at a temperature of 300° F. by superheated steam or by the products of combustion of natural gas. After drying, the board is seasoned by sprinkling with water to give the requisite amount of regain and it is then cut up by special machines into stock sizes for shipment. The material is light but strong, has excellent sound-proofing and heat-insulating properties, and finds many applications in building construction and industrial use. The sales figures are given as :—

1922	.. ..	18 million sq. ft.
1923	.. ..	35 „ „
1924	.. ..	55 „ „
1925	.. ..	105 „ „
1926	.. ..	190 „ „
1927	.. ..	237 „ „
1928	.. ..	260 „ „
1929	.. ..	333 „ „
1930	.. ..	Over 500 million sq. ft.

Every effort is being made to organize the cane-growing side on the most efficient basis so as to reduce the cost of the fibre. Other developments of the Celotex Company are : (1) a hard panel board capable of taking a high polish, (2) wrapping paper, (3) corrugated cardboard, and also (4) a laminated paper product impregnated with resin.

The success of the Celotex Company in Louisiana appears to be largely due to the extensive scale of their operations and the availability of large supplies of bagasse close at hand supplemented by the enormous resources of Cuba.

For the sugar industry of a colony to benefit by the use of bagasse for the manufacture of fibre board it is essential that the industry itself should control the fibre board factory. The mere sale of bagasse as a raw product is not likely to be very remunerative. There are, moreover, difficulties due to (1) the fact that the supply of surplus bagasse will be a very fluctuating quantity, dependent on the season, unless some other fuel can profitably be substituted in whole or in part, and (2) the question of storing the bagasse to which reference has already been made.

Vazcanc.—Another method of board manufacture known as the Vazcanc process, after its originator, E. A. Vazquez, effects considerable

economy in plant by combining the sugar extraction and pulp-producing stages and so avoids duplication of crushers, boilers and filter presses. The raw cane as received at the mill is finely comminuted by grinding between rollers of artificial silicon carbide driven at 1,200 revolutions per minute. The rollers, which are ribbed, tear the canes into fine-bundles of fibre and produce a pulp consistency of about 4 per cent. The pulp passes to a 12-stage counter-current washing system working on a bucket principle whereby 99 per cent of the sucrose is extracted at a dilution of 30 per cent. The fibre pulp is discharged into a storage tank and is thence fed to a beater which breaks down the few remaining slivers. Resin soap, copper sulphate and aluminium sulphate are added at this stage, the function of the precipitated copper resinate being to prevent mould growths. The pulp is fed from a stock tank to the board-making plant of the usual type. The wet boards, 1 inch thick and measuring 4 ft. by 8 ft., are stacked in a drying press, the pressure being regulated according to the type of board required. At 100 lbs. per sq. in. a $\frac{1}{4}$ in. board weighing 34 lbs. per cubic foot is produced and finds extensive use for the manufacture of furniture, crates, doors, etc. A denser board, $\frac{1}{8}$ in. thick, and weighing 68 lbs. per cubic foot, was found too hard to cut without damage to the saws. The power required for the initial grinding, 18.3 kilowatts per ton of dry fibre per 24 hours, appears rather high, but when allowance is made for sugar production and the saving in steam due to the heat generated by the grinding, a figure of 13.3 kilowatts is obtained, which compares very favourably with the 35 to 45 kilowatts consumed in grinding wood pulp for similar grades of wallboard. Only first-grade sugars are made in the plant and it appears likely that the value of the board will exceed that of the sugar. In an estimate based on a relatively small-scale trial, the output from a mill crushing 1,000 tons of cane per day would be :—

	Value $
Raw sugar, 122 short tons ..	5,490
Molasses, 30 short tons ..	210
Board (340,000 sq. ft.), 110 short tons ..	6,800

It has to be borne in mind that the adoption of the Vazcane process involves a radical change in the method of sugar manufacture and the replacement of existing mills and other equipment. It does not provide an outlet for any surplus bagasse from an ordinary factory.

In Jamaica a scheme for the erection of Vazcane fibre-board factory on the Serge Island estate is well advanced. It is understood that at least £70,000 is needed for the venture ; that the Colonial Development

Fund Committee has agreed to lend £20,000 free of interest for a certain number of years and that the Jamaica Government will guarantee the remaining £50,000, which will be subscribed for in the Colony.

Other Uses.

Feeding Stuffs.—The finer part of the bagasse is used in some cattle foods, such as Molascuit. The bagasse itself has very little food value but is of value as an absorbent of molasses. (See under Molasses.)

For Explosives.—The very fine portions of the bagasse, known as "bagasse flour", extracted by air suction, find a use in the manufacture of explosives, *e.g.*, as an absorbent in place of kieselghur in the preparation of dynamite.

Charcoal.—Charcoal briquettes can be made from bagasse and have possibilities of use as a substitute for coal in locomotives, etc., or in suitable gas-producer plants fitted to internal combustion engines.

Molasses.

Molasses is another by-product of the sugarcane industry for which many industrial applications have been found.

Rum.—From very early days one of the principal uses to which molasses was put was to ferment it for the manufacture of rum. The effect of high taxation and prohibition in recent years has been to reduce considerably the world's demand for rum and increased attention has been given to producing alcohol from molasses for other purposes than human consumption.

Power Alcohol.—Molasses is the cheapest raw material in common use for the production of alcohol for industrial purposes, the prices being governed by supply and demand. Alcohol is a suitable ingredient of fuels for internal combustion engines, imparting to them certain anti-knock properties. Its manufacture presents no difficulties. It is mainly, therefore, the question of price in competition with petrol which determines whether it can be used profitably as a motor fuel. In South Africa a mixture of alcohol and ether is marketed under the name of "Natalite". In Queensland a motor spirit known as 'Shellkol" is produced, consisting of a mixture of petrol, 85 per cent, and alcohol (from molasses), 15 per cent. In Brazil trials have been conducted with 'Azulina", consisting of alcohol with 5 per cent ether, denatured with 0.1 per cent of methylene blue. According to Dr. W. Freise on a 500-kilometre trial on the Rio San Paulo main line with heavy mountain grades the fuel consumption was 1.40 litres of "Azulina" per kilometre compared with 1.0 litre of petrol. The local price of "Azulina" is, however, only half that of petrol.

It is stated that extremely large quantities of discarded sugar and molasses are available in Brazil and that there is an eagerness to invest capital in the new industry.

In Mauritius the production of power alcohol, to which attention had been given for several years, was made a success about 1926. The Report of the Department of Agriculture for 1929 notes that there are seven distilleries at work producing alcohol for human consumption and for industrial purposes. Uganda has a factory at Lugazi, established in 1925, which produces power alcohol for local consumption; some methylated spirit has also been exported. In 1929 the Industrial Alcohol Ordinance was passed, providing that all spirits distilled in the Protectorate must, with certain exceptions, be converted into denatured alcohol.

Dry Ice (*Solid Carbon Dioxide*).—A factor which may make molasses fermentation highly profitable is the value of the carbon dioxide produced. A fillip has been given to the carbon dioxide industry by the development of a new refrigerant known as "Dry Ice" and consisting of compressed solid carbon dioxide. In America carbon dioxide has been exploited very largely, being used principally for carbonating beverages, in refrigerating plants and for conserving foodstuffs. To compress carbon dioxide and transport it in cylinders was found unprofitable owing to high freight charges, but the conversion into solid carbon dioxide offers distinct possibilities of more economical working. The bulk of the carbon dioxide used by the Dry Ice Corporation, which has a manufacturing capacity of over 30 tons of "Dry Ice" per day, is obtained by the combustion of coke, but at Yonkers there is a plant producing 10 tons per day and using the carbon dioxide from molasses fermentation. The purified gas is compressed in three stages, 75 lb., 300 lb. and 1,100 lb. After the first compression the gas is further purified by treatment with permanganate solution to remove traces of impurities, and is liquefied at 1,100 lb. pressure by cooling it to 70° F. in a condensing coil. The liquid is permitted to expand through a nozzle into a double-wall tank with a filter cloth top and in this the "snow" is formed, the unchanged gas escaping through the cloth and being returned to the compressors. The 'snow' is tamped in moulds and compressed at 500 lb. per sq. in. into a solid block. Forty to fifty per cent of the liquid can be converted to solid in one operation. The cost of the "Dry Ice" is higher than that of ordinary water ice but its advantages have been found to outweigh the additional cost. On long railroad journeys the use of "Dry Ice" in refrigerated vans is decidedly advantageous as is shown by the following tabulation:

	Water Ice		Dry Ice
	Ice	Salt	
	lbs.	lbs.	lbs.
Original charge	12,000	1,200	1,200
Replaced first day.. ..	1,995	200	Nil
Replaced second day ..	1,950	195	Nil
Replaced third day ..	1,750	175	Nil
TOTAL ..	17,695	1,770	1,200

Uses to which this material may be put are briefly:

(1) Light-weight packages of dairy produce, etc., for transport by post; cardboard containers can be used without damage through wetting.

(2) Ship refrigeration on short passages to avoid installing plant.

(3) Storing of products at extremely low temperatures.

(4) Freezing quicksand, etc., in excavation work.

(5) Local anæsthetic.

A plant to manufacture solid carbon dioxide is shortly to be erected near Melbourne, Australia, using the "Carba" process, which is of Swiss origin. The liquid carbon dioxide at 15° C. is expanded through special alternating nozzles to about 5.2 atmospheres so as to give a mass of "snow" wetted with liquid carbon dioxide. When the receptacle is full the expansion valve is closed and a valve at the bottom is opened, whereby the mass is frozen to a solid block owing to the evaporation of the liquid portion. The block is erected from the bottom and is cut as required.

COMBINED ALCOHOL, GLYCERIN ACETALDEHYDE AND DRY ICE PRODUCTION.

The following summary is given of a paper by N. M. Rydlewski in the *Proceedings* of the 1929 Annual Conference of the Association of Sugar Technologists, Cuba:—

"During the European War, unable to obtain the necessary supplies for explosives, the Germans used the nitrogen from the air and the glycerine from the spent wash of their distilleries, the latter according to processes which have been greatly improved since, now giving excellent industrial and financial results. Several shipments representing average Cuban molasses have been sent to Germany for practical trials employing these new processes, and gave the following yields (per cent molasses):—

Glycerine, 29.38 (twice distilled); 94 per cent alcohol, 23.52; and 75 per cent acetaldehyde, 16.72 per cent, yields which are higher than at present obtainable from German beet molasses. Assume yields of only 24 per cent of glycerine, equal to 2,840 lb. per 1,000 gall. of molasses; and 14 per cent of acetaldehyde, equal to 1,680 lb. per 1,000 gall. of molasses. Assume further that the distillery is making motor fuel composed of 60 gall. of alcohol and 40 gall. of sulphuric ether; the following is the commercial value of the various products that would be obtained in a distillery working from 50,000 gall. of Cuban molasses daily by modern methods:—18,162 gall. of motor fuel at 29 cents per gall., $ 5,226; 2,050 lb. of fusel-oil, 10 cents per lb., $ 205; 4,480 arrobas* of compressed carbon dioxide, $ 1 per arroba, $ 4,480; 144,000 lb. glycerine of 100 per cent, at 12 cents per lb. (18 cents in New York), $ 17,280; and 84,000 lb. of acetaldehyde of 75 per cent, at 18 cents per lb. (25 cents in N.Y.), $ 15,120. That is, a total of $ 42,351. Against this one sets the following manufacturing expenses:—18,162 gall. motor fuel (inc. tax), 35.4 cents per gall., $ 6,429; 2,050 lb. of fusel-oil without cost; 4,480 arrobas of carbon dioxide ('Dry ice'), 25 cents per arroba, $ 1,120; 144,000 lb. of glycerine, at 8 cents per lb., $ 11,520; and 84,000 lb. of acetaldehyde at 8 cents per lb., $ 6,720; that is, a total cost of $ 25,789. This gives a gross profit of $ 16,562, which, *less* 25 per cent for amortization taxes, insurance, administration charges, etc., leaves a net profit of $ 12,421. Glycerin thus made would find a market all over the world without competition (the manufacturing cost of the product of soap manufacture being much higher); while acetaldehyde is used in large quantities in the paint industry, and is besides the principal base of many products. Carbon dioxide compressed to 'Dry ice' lasts ten times longer than water ice, is very hygienic and finds employment in many industries; its loss by evaporation amounts to 10 per cent per day. Hence the result of this study is that a distillery by working up 50,000 gall. of molasses and producing glycerin and acetaldehyde in addition to alcohol motor fuel and the other by-products mentioned, can count on a daily net income of $ 12,421 per day; and the thought that occurs is the great possible value of the total molasses production of Cuba, amounting as it does to 250 million gallons per year."

Yeast.—In America, molasses has been put to yet another use and that is for the production of yeast, either for fermentation and bread manufacture or for human consumption and cattle fodder. In Germany

---

* 80 arrobas=one short ton; one arroba=25 lbs.

also, considerable advances have been made in breeding yeast cultures as a nitrogenous fodder for cattle. It is stated that 100 gall. of molasses will produce 50 lb. of fodder yeast or 400 lb. of baker's yeast. The methods of manufacture depend upon the initial composition of the molasses, and the treatments necessary for the preparation of a good yeast-growing medium are covered by a large number of patents. In general, the process consists in diluting to a suitable consistency, adding other nutrient materials such as phosphates, filtering, rendering alkaline with lime or caustic soda, decolourising with aluminium sulphate, again filtering. The ultimate aim is to create the most useful concentration of assimilable nitrogen for the growth of the yeast.

Feeding Stuffs.—Molasses is used on sugarcane estates as a feeding stuff. For purposes of transport an absorbent is desirable and in 1902 Mr. G. Hughes, of British Guiana, realised the possibility of using the finer portions of the bagasse for this purpose. The material so produced was called Molascuit and became an article of commerce. To make it a more complete food the deficiency in nitrogenous matter requires corrections, and various leguminous seeds grown for the purpose, or readily available, in the producing country have been added when ground to the mixture. Deterioration may, however, take place during transport and on the whole it is preferable that the preparation of such feeding stuffs be carried out in the consuming rather than in the producing country.

Fuel.—Molasses can be burned with good profit in ordinary factory furnaces, and with greater profit in furnaces of special though not expensive construction. In Australia all the northern mills, with the exception of some two or three, burn molasses as fuel in the furnaces without serious trouble in clinkering. In the Mackay area, one mill, Marian, utilizes molasses as fuel. Many of the other Queensland mills have attempted to burn molasses with no good result, owing to clinkering in the fires. This seems to be due to the nature of the ash itself, which is composed of salts with high potash and soda content. Marian mill returns primary mud on the mills, and the extra lime has a decided beneficial effect in reducing the clinkering trouble. Experiments carried out in Java in 1923 showed that when burning molasses alone it was possible to evaporate 2.1 lb. of water by burning 1 lb. of molasses of 89.5 Brix in a special furnace. The boiler efficiency of the furnace was 50 per cent. No record of the calorific value of Queensland molasses has been published, and an investigation on this matter is to be made by the Bureau of Sugar Experiment Stations, Queensland, in the near future.

In Java some factories burn a mixture of bagasse and molasses. The usual method, according to Harrefeld, is to distribute the molasses in fine drops by a perforated pipe on the bagasse, as it leaves the last mill. If the molasses is very thick it has to be heated. The bagasse must be very fine so that the molasses is thoroughly absorbed before the bagasse reaches the furnace, otherwise there is trouble with slag, which also ensues if too much molasses is used.

In the Philippines trials are being made of the value of baled bagasse supplemented by molasses fed from atomizing burners as fuel for locomotives. The cost of handling the surplus bagasse and molasses is stated to be about one-fifth that of the total cost of coal.

Fertilizer.—Molasses also has a fertilizer value, as it aids the nitrogen-fixing organisms and thus increases the nitrogen content of the soil, especially when lime is added. Molasses also contains an appreciable amount of potash which under appropriate conditions can be economically recovered. Molasses is burned, often after admixture with bagasse, in specially designed furnaces. The crude molasses contains between 3 and 6 per cent of potash and the efficiency of the recovery determines whether the operation is profitable or not. With careful supervision a recovery of 79 per cent is possible. One type of burner will consume 140 tons of molasses in 210 hours. 11.15 tons of molasses yield 1 ton of ash containing 27.74 per cent of potash (K_2O). The actual recovery is about 50 lb. of potash per ton of molasses.

Filter-Press Cake.

Wax.—Reference must also be made to an important constituent of the filter-press cake, namely, the cane wax. This wax is extracted by means of industrial alcohol giving a recovery of 4.06 to 5.27 per cent. Benzene is more efficient, but less profitable, owing to losses by evaporation, etc., and also the alcohol can be prepared on the spot by fermentation of molasses. The wax finds application in the shoe-polish, candle and sealing-wax industries. The chemical composition is somewhat complex. The residue after extraction of the wax has a considerable value as fertilizer.

Note Added.

Since the Conference was held there has been received the *Report of the Sugar Enquiry Committee*, 1931 (The Parliament of the Commonwealth of Australia, No 240, F. 971). A section of the Report, pp. 14–28, is devoted to the utilization of sugar by-products. It is clearly demonstrated that such utilization to be economically successful, depends

on local conditions. For example, in Australia, with no cheap alternative fuel available, it would appear impossible to divert bagasse from its primary function as fuel. The problems in connection with the production of power alcohol and other products are also dealt with from the economic standpoint.—*Bulletin of the Imperial Institute*, Vol. XXX, No. 1, 1932.

The Rise of Bee-Keeping

By S. W. Bilsing,

A. and M. College, College Station, Texas.

Man's association with the honey-bee began before the dawn of history. There are few animals which have helped man in such a variety of ways, in his struggle up the long road to reach the pinnacle which we now designate by the term, civilization. Honey was man's chief source of obtaining sugar. Wax served as his medium of exchange; furnished him with an artificial means of illumination; enabled him to develop a system of writing by furnishing a plastic yet semi-permanent substance on which characters could be made with sharp-pointed stylets; aided him in painting and sculpture; and by moulding it into candles he could worship his deity.

Savage tribes have kept bees ever since man began to record his activities. His first interest in the honey-bee, no doubt, was prompted by his craving for sweet substances. Since this was the only readily available source of obtaining something sweet in a concentrated form he early expended his energies in enticing bees to live in hollow logs, perhaps later in earthen vessels or baskets made of grasses. This was the beginning of thousands of years of association during which man's well-being was augmented religiously, morally and materially by the honey-bee which served him to even a greater degree then than it does to-day. Just when he became an apiarist would be difficult to learn. Figures of bees appear on Egyptian monuments as early as 3500 B.C. There are also numerous biblical references as well, which lead us to believe that his apiarian tendencies must go back for thousands of years.

Its ability to store honey and produce wax—two substances which were of inestimable value to him—early excited not only his admiration, but also his interest in learning something about them. Because of the many references in the records of the ancients, it would seem that he devoted no small amount of energy to a study of their habits. The ancients seemed to have had some knowledge of parthenogensis in the honey-bee since they started, "The bee is unlike any other animal in that

it never mates". This belief must have led to their associating it with their deities. Many of the gods of the ancients were born of virgins, thus, the bee became the symbol of resurrection and the renewal of life. The industry and self-sacrifice of the honey-bee were a marvel to them; hence to them the honey-bee became the symbol of industry, purity and chastity.

In the course of time the honey-bee became connected with many of their religious beliefs. It played an important part in the lives of the Egyptian as well as the Roman and Greek divinities. Pausanias, the Greek historian, tells us that one of the oldest temples dedicated to Apollo was raised by bees from wax and wings. The mythology of the Romans as well as the Greeks refers to the honey-bee. Among the Romans the bee had a divinity of its own, Mellonia. Pan was supposed to have been the guardian of the bees and Virgil tells us that Pan invented a musical instrument which he made of reeds joined together with wax. The early Christians referred to the honey bee as the Maid Servant of the Lord. It was natural for those who believed they were the direct representatives of the various divinities on earth to use the honey-bee as their insignia. Thus, it was emblazoned on the crown of the Pharoahs; on the arms of the Pope and on the imperial robes of the Napoleons.

Honey was used in many religious ceremonies. Its preservative qualities were also known to the ancients. The Assyrians and the Persians, as well as the Egyptians at times covered their dead with wax and then placed the bodies in honey.

From the earliest times wax-candles were associated with religious ceremonies. That there was some occult mystery connected with the use of wax-candles seems evident since all of the early pagan peoples used them in connection with their sacred rites. The persecution of the early Christians compelled them to meet in the catacombs. Here they made use of the candles for lighting purposes. Later when they began to build churches they found these sacred edifices so dark that they continued to use wax-candles for illumination. This seems to be the origin of the use of wax-candles for ritualist purposes which has continued to the present day.

Wax was also used by the ancients in the arts. Pliny tells us that "It was not agreed who was the inventor of the art of painting in wax, some thinking that the credit should be given to Aristides of Thebes who was the first of all painters to give full expression to the mind and passions of man." The painting of ships of war was effected by melting wax colours and putting them on with a brush while still hot. That

this method of painting resisted the effects of the elements is attested by the fact that the vast mural paintings taken from the ruined houses of the patricians in Pompeii can still be seen after eighteen centuries.

When a man became famous his figure moulded from wax was placed in public buildings. Pliny tells us that Lysistratus was the first to study how to secure a faithful likeness of the person represented. He did this by fitting a plaster mould to the face and then pouring molten wax into the cast.

One of the earliest uses of wax was for making light. The primitive candle was made by taking the pith of a rush and dipping it in wax. Public lighting was introduced by Constantine in the fourth century when he ordered the entire city of Constantinople to be lighted on Christmas Eve.

Wax was also the medium of exchange. It was customary to impose taxes in wax. It was also the custom of the Romans to exact the tribute from the nations which they conquered, in wax.

Another of the uses of wax which seems to have contributed materially to man's progress was his use of it for correspondence and the retention of temporary inscriptions. For this purpose wooden tablets were covered with wax and the characters were traced with metal stylets. The Romans wrote their letters on this tablet and the person receiving the letter smoothed out the wax and sent back their reply on the same sheet.

Thus, it may be seen that in ancient times bee-keeping was an important activity of every farmer and afforded no small part of his income. Bees supplied him with honey as well as with wax. Honey, no doubt, satisfied his craving for sweet substances, served him in his sacred rituals and initiations and even in the preservation of his dead. Wax, he used in writing his love letters; in preserving the casts and images of his great men as well as his loved ones; in painting and sculpture; and to his discredit in magic and sorcery as well as in medicine; in paying taxes to his king; and the conqueror in collecting tribute from those whom he vanquished. It furnished him with a method of illumination to dispel the darkness of the long nights. Scarcely without exception it afforded him a means of offering supplication to his deity, whether it were the Egyptians in their worship of Apis, the Zoroastrians in their worship of the Sun God, or the celebrations held in Attiva in honour of Ceres, the Goddess of Corn. Later, when he believed himself to be the direct representative of his deity on earth, he used the bee as a symbol on his crown, coat of arms or imperial robes, depending on his status in reference to his fellow-man.

So, with the passing of the ages, man's knowledge of bees and bee-keeping slowly progressed. He invented and discovered many new things and many of the uses he originally had for honey and wax were supplanted by the other things he invented or discovered.

With the invention of printing it was possible to exchange and permanently preserve the information he collected. Between 1568 and 1700, twenty-four publications were issued on bee-keeping. In 1845, the first of three great events, modern bee-keeping, happened. In that year, Dzierzon, a Polish Catholic priest of Karlsmarkt in Silesia, discovered parthenogensis. This was a great step forward, but his views were not readily accepted. When Siebold, Leuckhart and Leidy, with the aid of the microscope confirmed Dzierzon's discovery a great impetus was given to bee-keeping. Although the Egyptians and Babylonians must have had an inkling of this fact, this information evidently was not entirely confirmed or else was lost in the middle ages. This discovery was not only of great importance to bee-keeping, but to biological sciences in general. It explained many things that had worried careful observers for a long time.

In 1851, six years after Dzierzon discovered parthenogensis, L. L. Langstroth invented the first practical movable frame hive. It would be difficult to estimate which has had the most influence in the development of bee-keeping.

In 1865, Major Hruschka at Dolo, near Venice, Italy, discovered that it was possible to throw honey from combs by centrifugal force. From this idea has evolved curious types of extractors beginning with the original single frame extractor devised by Major Hruschka to the improved ones of to-day.

In 1873, Moses Quinby invented the bellows smoker, which has greatly facilitated the handling of bees. The origin of comb foundation seems to have been an evolution of the ideas of several people.

There are few of the many inventions and discoveries which have linked ancient bee-keeping with the bee-keeping of to-day.

Man has studied bees a long time. During that time he has learned much, but he has also contributed to his own difficulties. Primitive man attributed to the honey-bee all the virtues except hospitality, for he observed that a bee from one colony was not permitted to enter another colony. Since primitive tribes were intent on reserving their tribal integrity they recognized this as an admirable trait. It was also considered as an ill omen to transfer bees from one owner to another. On that account it would be logical to believe that the diseases of bees were not

disseminated to a great degree because colonies of bees seldom changed owners. But with the coming of rapid means of transportation, man has spread bee diseases over much of the earth. This in time bids fair to eliminate all but those who are willing not only to acquire a knowledge of bee behaviour and bee diseases, but also to put this information into practice.

This, no doubt, will have an important bearing on the future, not only of bee-keeping, but also the usefulness of the honey-bee in the role of pollination. The importance of the honey-bee in this respect is well known to all of us. We have recounted that bee-keeping was an important activity and furnished an important part of the income of every farmer in ancient Egypt, Greece and Rome.

The wide-spread presence of bee diseases, it would seem, will more and more limit the keeping of bees to a smaller number of people. Bees are necessary for the pollination of many kinds of fruits and vegetables. One of the important problems of the future will be to provide a sufficient quantity of bees for pollination at the proper time. Southern bee-keepers are able to produce the bees at a minimum cost. Our northern friends tell us they would be glad to get our bees, provided they could depend on us to ship the bees at the time they are most needed. But, when so much is dependent on having bees at the proper time and that time is so limited they can afford to depend only to a limited extent on shipments of bees from the south. If bees can be produced in the south much cheaper than in the north, then it would be to the advantage of both northern and southern bee-keepers to arrive at a better understanding of this problem. Perhaps the most limiting factor in the solution of this problem is the high express rate which consumes a large part of the profit of the producer.

One of the most important problems confronting the bee-keeping industry is a proper system of marketing. This is a problem which has been discussed a great deal and yet we have not made much progress in its solution. There are so many factors involved that it challenges our best efforts.

In many parts of the south, honey is gathered from a variety of sources and over a long period of time. As a consequence the honey is seldom of the same flavour or colour in two successive years. The American consumer has come to demand a standard colour and flavour. If some inexpensive process could be devised that would standardize the colour of this honey, bee-keepers in these localities would not be at a disadvantage as they are at the present time.

Wintering is an expensive problem in many parts of the far north. In most localities of the south, bees can be produced at a small cost. Some data over a long period of time as to whether or not it would be profitable for the northern bee-keeper to destroy his bees in the fall and purchase bees from the south is a much-needed information in bee-keeping.

This section began as a section on apiary inspection. The various states have not as yet agreed on any uniform regulations on bee inspection and the treatment of American Foul Brood. Uniform regulations on shipping package bees and queens would also be a desirable improvement.

Sugar is supplied to the American public largely from foreign sources of production. If sugar can be produced and shipped to this country and refined at a less cost to the consumer than the American bee-keeper can afford to take for his product, perhaps we need to further investigate our methods of honey production to see if our present methods cannot be improved upon.

In parts of the south-west vast stretches of native plants that are good honey plants are being destroyed to give place to modern agriculture. Are there any plants that can be cultivated profitably to take their place in these regions?

Again and again we hear "That honey is the sugar best adapted to the human system". That being the case, we are doing a great injustice to the human race by not forcing upon them wholesale the consumption of honey. It is needless to say we need more information on the chemistry and the food value of honey as well as on the physical condition.

Genetical studies of the honey-bee have been made possible by the recent work in artificial insemination. This is a field well worth exploration and should yield much valuable biological information.

These are but a few of the many questions either awaiting solution or questions on which more information is needed. Bee-keeping was one of primitive man's earliest interests. It should be much more interesting to-day. Its problems are still many and sufficiently varied to challenge the best there is in any of us.—*Journal of Economic Entomology*, Vol. 25, No. 3.

Award of the Maynard-Ganga Ram Prize.

In 1925 the late Sir Ganga Ram, Kt., C.I.E., M.V.O., R.B., Lahore, with that generosity for which he was so well known, handed over to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize of the value of Rs. 3,000 to be called the Maynard Ganga Ram Prize and to be awarded every three years, for a discovery, or an invention, or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all throughout the world. Government servants are also eligible to compete for it.

Sixty-four entries were received in competition for the first award of this prize. Out of this number, however, only fourteen complied with the conditions of award. Four Committees of Judges were appointed to examine and report on these entries. Their reports were considered finally by the Managing Committee of the Prize on 3rd March 1931, when it was decided that the prize should be awarded to Dr. C. A. Barber, Sc.D., C.I.E., 294, Cherryhinton Road, Cambridge, for his fundamental discoveries which have resulted in the production of Coimbatore seedlings sugarcanes. These canes have been definitely proved to be much higher yielders under Punjab conditions than the old indigenous varieties. The area under Coimbatore sugarcanes in the province is increasing rapidly each year and it is expected that they will totally replace indigenous varieties in a few years' time.

Applications for the next award should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1932.